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Service Paper

INSTRUCTIONAL MATERIALS AND METHODS AVAILABLE TO SUPPLEMENT A SMALL HIGH SCHOOL SCIENCE CURRICULUM

Submitted by

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In partial fulfillment of the requirements for
the Degree of Master of Education

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CHAPTER I

THE PROBLEM

CHAPTER I

THE PROBLEM

The problem is to bring to the attention of all students available materials which may supplement the programs of study of a small high school. Regardless of the size of the school concerned, both the non-college and the college preparatory student must be adequately prepared to take their place in the community, in the city, or in the university or college of his choice. In a small school where limitations of subject matter and teacher personnel exist, a student is handicapped to a certain degree. Many schools in this group have difficulties in meeting the common and specific needs of all its youth.

The procedure will be to read literature in the field, contact the main sources or agencies for catalogues and bulletins, establish certain objectives, construct specimen unit assignments, contact thirteen State Departments of Education in various sections of the country, acquire sample correspondence course lessons in the field of science, and make a survey of the programs of study in all the high schools in the state of Massachusetts with enrollments of 200 or less.

Chapter II will present a summary of the readings and a breakdown of the science course offered by the leading

correspondence schools in the country and all the small high schools in the state of Massachusetts.

Chapter III will present the general and specific objectives of education.

Chapter IV will present a brief summary of the scientific and unit methods including specimen units of the four traditional science courses.

Chapter V will include a summary and facts pointed out by this research.

From this study, it is hoped to bring to the attention of all secondary school students, all college students, and all persons not attending school who are interested in furthering their education the methods and types of materials available to supplement or augment their present educational level. It is primarily for the ambitious small-high-school pupil who seeks to overcome certain shortcomings in the offerings of the local program of studies. By applying certain methods and by utilizing the academic, vocational, and technical courses offered by various state Departments of Education and the leading correspondence schools, small-high-school pupils could be as well prepared for college and life as the pupils in any of the other secondary schools in the United States.

CHAPTER II

PRELIMINARY STUDIES

CHAPTER II

PRELIMINARY STUDIES

From the following selected readings, available materials and methods of expanding the small high school curriculum offerings will be evolved.

An important problem which faces all high schools in this class is how to increase the educational offerings with a limited corps of teachers. A limited corps of teachers leads to a limited number of courses offered in turn. The result is an inevitable limitation of the school's offerings and potentialities.

To overcome these limited offerings and potentialities, methods such as alternation of subjects, consolidation of schools, correspondence courses, and circuit teachers may be utilized. Summer and evening courses are also available.

Probably the most common method is to alternate subjects. By alternating courses, the program of studies may be greatly increased.

> "As a rule, courses which are organically and vocationally alike should be alternated. This method is most commonly applied to third and fourth year courses but can also be used with other courses. The major criterion is whether the earlier courses are prerequisites to later courses. Most of the subject fields readily lend themselves to the alternating procedure. It is common practice to alternate such courses as third and fourth year English, second year algebra and geometry, chemistry and physics, or biology or any two of these sciences, third and fourth year Latin, second and third year agriculture and home economics, general science and general mathematics, any two courses in history

and the first and second years of two modern languages, should any school offer such an elaborate program of studies."[1]

Of all the available materials, supervised correspondence study is one of the more recently developed methods of teaching in a small high school. This plan is a method of supplementing the curriculum of a local resident, public or private, school by use of texts and instruction service. It is a method whereby any school may successfully and economically offer a wide variety of courses of study to meet the needs of every student. Mail service by a highly specialized subject-matter teacher located in the correspondence center replaces the teacher in the local classroom.

Correspondence courses had their beginning in the United States in 1891. At that time, Dr. William Rainey Harper, president of the University of Chicago established a division of correspondence study. This was the beginning of university and college correspondence study. This practice grew so rapidly that by 1930 sixty-three universities and colleges had undertaken the offering of such courses. The correspondence movement in secondary schools began in the year 1923. At that time, Superintendent Sidney C. Mitchell began experimenting with the use of correspondence courses in the Benton Harbor (Michigan) high school for the purpose

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[1] R. Emerson Langfitt. The Small High School at Work, American Book Company, Boston, 1936, p. 213

of enriching the curriculum with vocational subjects. Superintendent Mitchell realized that many students were not taking courses they needed most. He arranged with a few to enroll in special vocational courses in which they showed particular interest. The values of each course proved themselves forthwith, and the Board of Education immediately endorsed this type of study as a regular part of the educational program.

Today (1948) approximately 10% of all the public high schools in the United States have now adopted this so-called "Benton Harbor Plan", and tens of thousands of public high school students have thus and are continuing to pursue an enriched curriculum through the correspondence method of instruction.

In brief, the plan is as follows:

1. Designate a director to take charge of the correspondence study department of the school.

2. Establish a connection with one or more correspondence schools offering approved courses of study by the correspondence method.

3. Set aside a double class period each day during which time the student or students will prepare their lessons under the supervision of the director, and

4. Mail the prepared lessons to the home office of the cooperating home study school for correction and return.

Thirteen different State Departments of Education were contacted to determine the methods used by each to overcome the limitations of their small high school programs. The questionnaire went to the six New England states, two states in the South, three in the mid-west, and one to the far west. Of the questionnaires sent out, twelve replies were received. The State Department of Education in Massachusetts is the only one of the group covered that offers a very elaborate program of correspondence courses. To be sure, certain states are rendering assistance to small schools by means of administrative reforms, higher qualifications of professional personnel, increased appropriations, and provisions for better state aid; but a relatively few have taken any action towards providing methods to overcome curriculum limitations. The general attitude of State Departments of Education, at least the 27 per cent covered, seems to be one of leaving it to local systems to provide the best possible, with the materials and personnel on hand. When the occasion arises, organize a new body of constructive material which shall be richer, broader, and better for the pupils. Those who follow this procedure will fail to meet all the immediate needs of all small-high-school pupils. The most recent data of nation wide scope on the program of students of small schools, reveal that the subjects offered by one half or more of the schools, are English, Latin, geometry, American History and general

science. If all the subjects included in the programs of 25 to 49 per cent of the schools are added, this list is increased by one year of a second foreign language; three courses in history and a course in civics; three courses in science; one year each of agriculture, home economics, typewriting, and bookkeeping and physical training.

In the state of California, the legislature recently made it possible for public high schools to offer correspondence courses when it is impossible to employ a teacher to instruct the few students who might want a given course. At the present time, the University of California is the only approved teacher training institution which offers correspondence courses. The university has adequate facilities to provide instruction in a total of 86 courses approved for acceptance by the university in fulfillment of entrance requirements. Through proper arrangement prior to enrollment with the high schools, colleges, and universities, it is now possible in California to receive credit for the work satisfactorily completed by correspondence study.

A recent pamphlet[1] sets forth the following specific purposes for which supervised correspondence study is intended:

1. To expand and enrich curricula of small or large high schools and to make available broader general educational experiences and specialized fields:
    - a. By providing courses in vocational subjects.
    - b. By offering subjects which meet specified college entrance requirements.
    - c. By offering to the gifted boy or girl suitable subjects for which usual demand is small.
    - d. By offering courses for the irregular students, thus making some progressive achievement possible.
2. To provide courses for which a teacher cannot be employed. This is especially important during the immediate postwar period.
3. To bring high school education to the rural or isolated student who is unable to attend secondary school.
4. To enable the handicapped or incapacitated student to obtain an education.

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[1] Life Long Learning-High School Supervised Study by Correspondence 1945-1946 published by University Extension, University of California.

5. To offer worth-while courses to post-graduates and adults suitable alike to those in civilian life and those in the armed forces.
6. To lessen the teacher load.

Another significant development in the field has been carried on by the University of Nebraska in cooperation with the Carnegie Foundation for the advancement of Teaching and with the high schools of the state.[1]

> "Through its Extension Division, and in cooperation with the faculty of the Teacher's College, it offers courses which make possible a broad cultural curriculum which smaller high schools need if individual differences are to be served. This project was initiated in 1929. By 1936 there were 600 pupils in 220 high schools enrolled for 1,200 individual courses in supervised correspondence study through the University Extension Division. The university was not merely training teachers for the high schools of the state; it was actually participating in the teaching process within the schools. In 1935 it offered courses in the following fields: fine arts, commercial art, mechanical drawing, English language, home economics, foreign languages, mathematics, natural sciences, and social sciences. In addition, there were remedial courses in arithmetic, foreign language, and reading."

Although some State Departments of Education have established Extension classes and Home Study courses, the International Correspondence Schools, Scranton, Pennsylvania, is without a doubt the leader in this field. This school is conducted in the same manner as any regular high school. There are classes in the fields of English, history, mathematics, science, etc. Each group is under the direction and

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1/ Op. cit., pg. 260

guidance of a qualified instructor in the subjects taught. The group spends a definite portion of each class hour on each of the different subjects being studied. In other words, it is conducted just like the regular method except the International Correspondence School texts and instruction service are used in conjunction with the resident instruction. Flexibility of this service makes it superior to regular classroom instruction alone. It takes care of individual differences so that a student proceeds as rapidly as he wishes. The fast are not held back with the slow. A student may matriculate at any time; he does not have to wait for classes to be organized.

Among the definite advantages of supervised correspondence study will be found the following: (1) it provides means of revising the curriculum and improving the quality of instruction; (2) it provides an economical method of carrying education to the pupil studying alone and makes it possible for him to enjoy the advantages of a course even though a large class in the same subject cannot be organized; (3) it permits the use of new methods of teaching which have just been developed; (4) and it offers a method of serving adults and post-graduates effectively through courses which they really need and which cannot ordinarily be offered by a small school.

Information regarding correspondence courses offered by State Universities, State Departments of Education, the International Correspondence Schools, the United States Armed Forces Institute, and the National Home Study Council will be found in the cellophane inserts at the rear of this paper.

Several states in the United States, notably Connecticut and New York have made real progress in the establishment of regional or consolidated high schools, in which two or more towns combine to erect a high school building, with each town's share of the capital investment previously determined, as well as the operating expense when the school is functioning.

There are many benefits under such a plan. Two towns, for example, which are contiguous, instead of building two separate high schools, one in each town, would erect just one. Instead of necessitating the expenses involved in the construction and the maintenance of two buildings, there would be only one. There would be corresponding benefits with relation to the school personnel and school program. The larger the school, the more likely that the salary scale will be higher, and therefore, tenure and continuity of the work should be better. With a large school, it is possible to have a greater spread of courses in the various subject fields. The small school is likely to be limited to academic classes. The extremely small class, sometimes including less

than five pupils, can be eliminated in a larger school. The per pupil cost would not be as high in a larger school as compared with a small one. There would be an opportunity to greatly increase the curriculum offerings. Furthermore, with the improvement in roads and means of transportation, the transportation problems of the past can now be easily met.

The following is quoted from a recent article by the[1] Supervisor of Secondary Education in the state of Massachusetts.

> "It is true that we have too many small schools in the state. There are eleven under 50 pupils and forty-five under 100 pupils. The optimum size of a high school is probably about 800 pupils. A small high school may mean inefficiency in program and classes, and a very much larger high school boarders on the "factory method" of education. In Massachusetts the median high school is about 650 pupils.
>
> It should always be realized that in Massachusetts we take a tremendous pride in the local prerogative and the local initiative of the 351 towns and cities. There is the conviction in a small town that giving up its small high school will mean the loss of all community life, also that the citizens cannot so easily see "their own in action." Other states have had a more aggressive attitude on a state-wide basis in determining which towns might well establish union high schools."

In the mid-west and some of the southern states the practice of utilizing circuit teachers has aided materially in overcoming the curriculum limitations. This procedure offers instruction in some subjects which one school alone cannot afford. Often schools cannot afford an additional

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[1] A. Russell Mack, Union or Regional High Schools in Massachusetts. The MSSPA Bugle, October, 1948.

teacher but can bear the expense of a part-time teacher. These circuit teachers who are specialists in certain fields are employed on a part-time basis. Their employment being a cooperative affair with each town contributing a pro-rata share of the services rendered. The time spent in each school would vary with its individual needs. The expenses of each community would vary accordingly.

Many secondary and preparatory schools offer summer and evening schools which are open to students and adults alike. In this category will be found college preparatory, commercial, business, technical, and vocational schools offering a variety of subjects open to all interested and ambitious individuals. Within the last few years, many attempts have been made to aid the student who is so unfortunate financially or mentally as not to be able to attend the regular school day sessions. The part-time and evening schools now are enabling large numbers of adolescents who have to work during the day, to continue their secondary education at hours more favorable to them. The commercial, vocational, and trade schools are serving many more who are not interested in taking a college preparatory curriculum. This is a decided advantage to the students of the smallest high school who find themselves in a school whose chief aim is to prepare its pupils for entrance to college or university. Summer schools are available for others who are unable to

find time during the regular school year. Thus, by accomodating their schedules to the working demands of some and by offering technical training to others, these special types of schools have attracted many adolescents and adults who would otherwise never have secured a secondary school education. The summer High School conducted by the Worcester Junior College and the Lincoln Preparatory school in Boston are typical schools.

In attempting to establish a four year science course in a small high school which will fit the needs of both college and non-college preparatory students, the pattern of unit arrangements or closely related correspondence courses could be put to a very worthwhile practice. Heterogeneous groups found in most small high school classes must be presented with the proper skills and concepts to fit the needs of each individual student. In the majority of schools of this type, a small percentage of the graduating classes ever continues its education. On the other hand, teachers are faced with the problem of preparing the majority in the necessary skills, concepts, appreciations and attitudes for a worthwhile living or in terms of the vocational opportunities of the community. This same problem prevails throughout the curricula of a small high school and is not necessarily confined to the field of science.

Billett says,[1] "Such a class presents to the teacher merely a greater problem of providing for individual differences. It calls for greater flexibility in the unit assignment. To the extent to which the college entrance examination tests for concepts, skills, ideals, attitudes, and appreciations of vital importance in daily living, the differentiation for college preparatory and non-college preparatory pupils is only the differentiation that would be made for the different aptitudes, abilities, interests, aims and and needs of any group of pupils. To the extent to which the examination emphasizes materials relatively non-functioning in everyday life, to that extent the unit assignment must be differentiated to enable the college preparatory pupils to acquire such materials, but so far as possible by the experience route rather than by parrotry. In such a class, college entrance is merely one of many individual differences for which a psychologically organized course most provide."

According to Surveys[2] taken, the following physical sciences are offered by high schools in the United States: physics, chemistry, physical geography, geology, and astronomy. Physics and chemistry are by far the most frequently taught with the greater enrollments in chemistry taking place in the larger schools with physics predominating in the smaller schools. Although the enrollments in chemistry seem to be at a standstill, there appears to be an apparent decline in the physics classes. One finds physics and chemistry most frequently offered in the junior and senior years. In the small school, a general practice is to alternate the two courses granting each pupil an opportunity to take both courses. When both courses are offered in a small school,

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[1] Roy O. Billett. Fundamentals of Secondary School Teaching, Houghton, Mifflin Company, Boston, 1940 p. 274

[2] Biennial Survey of Education 1926-1928 by Bureau of Education, Washington, D. C.

physics is usually taught in grade eleven with chemistry being taught in grade twelve.

While the physical sciences offer a field for the study of inorganic matter, biology opens the door to an understanding of organic substances. Biology preceded by General Science is usually taught in grade ten. Presented in this manner, the science courses of a small school would be well intergrated.

The recommendations of the committee on the Reorganization of Science in the Secondary Schools[1] for a four year high were as follows:

Grades Nine to Twelve

Ninth year -- Science five periods per week.
Tenth year -- Biological science or physical science.
Eleventh year -- First year physical science (physics) or first year biological science; second year biological science or second year physical science (chemistry).
Twelfth year -- Elective selected from those listed under the offerings for tenth and eleventh grades and such other electives as the school may choose to offer.

The committee recommended that the work of the ninth grade be required and that the work of grades ten, eleven and twelve be elective.

NATURE AND SCOPE OF SCIENCE

Since the establishment of the first high school in America, in 1821, science courses have become greatly modified in at least two respects. In the first place, there

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1/ Bureau of Education Bulletin No. 26, 1920 p. 23.

has been a tendency to eliminate certain of the science subjects, previously offered, from the high school curricula; and in the second place, there has been a tendency to change the contents and the points of emphasis of subject matter under certain science subjects. During the past one hundred years, science courses composed of botany, zoology, astronomy, geology, physical geography, physiography, hygiene and sanitation, health, anatomy and physiology have been replaced by the more traditional courses. Fusing of botany and zoology into one biology course and the fusing of physics and chemistry under one heading are only two of the more recent trends in this particular field. By adhering to the more traditional courses and fusing of certain others, the smaller schools have profited.

REASONS FOR NEED OF SOLVING PROBLEM

As previously stated, teachers in small high schools are confronted with large heterogeneous groups, a large majority, and in some schools all, who will never go to college and most of whom will never get any schooling beyond that provided by the local high school. Regardless, provisions must be made for both groups. In meeting the needs of the majority or the non-college group, small high schools with their limitations have done a remarkable job. However, in facing these limitations, the college students may find specific college or university requirements not being offered

by their particular school. Whereas the majority may adhere strictly to the traditional course of study, the college group must explore further. This group must be provided with types of activities for the attainment of experiences and contacts which will develop in them accurate habits of thought, a desire to experiment and explore for themselves, an understanding of various methods of research and problem solving, and an understanding of the information required to lead a successful college life. In addition to the school's offerings these students should be familiar with supplemental materials and methods available. Furthermore, graduates and former students who are desirous of improving their standards of living should also be acquainted with these materials. To bring this information to all groups mentioned above is the purpose of this work.

Although the trend in curriculum offerings in a small high school has been in the direction of subjects more closely related to contemporary life and to needs in both practical and cultural aspects, further exploration must be heeded by those planning to continue their formal education after they leave or graduate. These individual differences and the challenges faced cannot be disregarded.

A BRIEF HISTORY OF SCIENCE

During the colonial days, great emphasis was placed on the three R's with no thought being given science in any of its forms. However, we find sciences being introduced in the academies during the eighteenth and the public schools in the nineteenth century. With the beginning of the twentieth century, the general science movement originated. During the past forty years, a large number of schools have adopted science courses which have proven introductory to the more highly specialized biological and physical science courses. More recently, the four traditional courses will be found in the majority of secondary schools. In keeping with this trend, the following tables of the small high schools (enrollments under 200) in the state of Massachusetts will reveal few exceptions. A course in aeronautics appears almost as frequently as the four major courses. Health, agriculture, consumer science, hygiene, junior science, and aeronautics supplement the aforementioned traditional science courses in the more rural districts.

TABLE I

SCIENCE COURSES OFFERED IN MASSACHUSETTS HIGH SCHOOLS WITH A 101 to 200 ENROLLMENT

School	General Science	Biology	Chemistry	Physics	Aeronautics	Hygiene	Consumer Science	Advanced Science	Health	Radio Code
Acton	1	1	1	1						
Ashland	1	1	1	1	1			1		
Ayer	1	1	1	1						
Barre	1	1	1	1						
Bellingham	1	1	1	1	1					
Bourne	1	1	1		1					
Bridgewater		1	1	1						
Charlton	1	1	1	1		1				
Cohasset	1	1	1	1						
Deerfield	1	1	1	1						
Douglas		1	1							
East Bridgewater	1	1	1	1	1					
Grafton	1	1	1	1	1					
Groton	1	1	1	1	1					
Hadley	1	1	1			1				
Hamilton	1	1	1	1						
Hanover	1	1	1	1	1					
Hatfield	1	1	1							
Holbrook	1	1		1						
Hollison		1		1						
Hopedale	1	1	1	1	1					
Hopkington	1	1	1	1	1			1		
Kingston	1	1	1	1	1					
Leicester	1	1	1							
Lenox	1	1	1	1	1					
Marshfield	1	1	1	1						
Medfield	1	1		1						
Medway	1	1	1	1						
Millis	1	1	1	1	1					
Nantucket	1	1	1	1						
North brookfield	1	1	1	1						
Oxford	1	1	1	1	1					
Pepperell	1	1	1	1	1					
Provincetown		1		1	1					
Rockport	1	1	1	1	1					

1/ Massachusetts Department of Education, High School Survey, Report on the Organization and Administration. 1946-47.

TABLE I (continued)

School	General Science	Biology	Chemistry	Physics	Aeronautics	Hygiene	Consumer Science	Advanced Science	Health	Radio Code
Stockbridge	1	1	1	1	1					
Templeton	1	1		1						
Tewksbury	1	1	1	1						
Townsend	1	1	1							1
Warren	1	1	1	1						
Wayland	1	1	1	1						
West Bridgewater	1	1	1		1			1		
Westford	1	1	1	1	1					
Weston	1	1	1	1						
Westport	1	1	1	1						
Westwood	1	1	1	1						
Wrentham		1	1							
Totals	42	47	42	39	19	2	1	3		1

Op. cit.

TABLE II

SMALL SCHOOL SCIENCE COURSES

ENROLLMENT 50 to 100

School	General Science	Biology	Chemistry	Physics	Aeronautics	Hygiene	Consumer Science
Ashfield	1	1	1	1			
Avon		1	1	1	1		
Belchertown	1	1	1				
Bernardston	1	1		1			
Brimfield	1	1	1				
Burlington	1	1	1	1	1	1	
Chatham	1	1	1	1			
Chester	1		1				
Duxbury	1	1	1	1			
Edgartown	1	1	1	1			
Goergetown	1	1	1	1	1		
Groveland	1	1	1	1	1		
Hardwick	1	1	1	1	1	1	
Harwick	1	1	1				
Huntington	1	1	1	1			
Lancaster	1	1	1	1	1		
Littleton	1	1	1	1			
Lunenburg		1	1	1			
Manchester		1	1	1			
Mendon	1	1	1	1			
Merrimac	1	1	1				
Monson		1	1	1			
New Salem		1		1			
Northborough	1	1	1	1			
Northfield	1	1	1	1	1		
Norton	1	1	1				
Norwell	1	1	1	1			1
Oak Bluffs	1	1	1	1			
Orleans		1	1	1			
Pembroke	1	1	1	1			
Plainville	1	1	1	1	1		
Princeton	1	1	1	1			
Rutland	1	1	1	1			

Op. cit.

TABLE II (continued)

School	General Science	Biology	Chemistry	Physics	Aeronautics	Hygiene	Consumer Science
Sheffield	1	1	1	1	1		
Sherborn	1	1	1	1	1		
Southboro	1	1	1				
Stow	1	1	1	1			
Sudbury		1		1			
Sutton	1	1		1			
Tisbury	1	1	1				
Topsfield	1	1	1				
Upton	1	1	1				
West Boylston	1	1		1			
West Newbury	1	1	1		1		
Williamsburg	1	1	1	1	1	1	
Totals	38	45	40	34	12	2	1

Op. cit.

TABLE III

SMALL SCHOOL SCIENCE COURSES

ENROLLMENT 0 to 50

School	General Science	Biology	Chemistry	Physics	Aeronautics
Ashby	1	1		1	
Brookfield		1			
Charlemont	1	1	1	1	1
Dover	1	1	1	1	
Harvard		1		1	
New Marborough	1	1	1	1	
Petersham	1	1	1	1	
Sandwich	1	1	1	1	
Wellfleet	1			1	
Totals	7	8	5	8	1

Op. cit.

TABLE IV

MASSACHUSETTS

SMALL HIGH SCHOOL SCIENCE COURSES

RECAPITULATION

No.	School Enrollment	General Science	Biology	Chemistry	Physics	Aeronautics	Hygiene	Consumer Science	Advanced Science	Health	Radio Code
47	101 to 200	42	47	42	39	19	2	1	3		1
45	50 to 100	38	45	40	34	12	2	1	0	0	0
9	0 to 50	7	8	5	8	1					
101	Totals	87	100	87	81	32	4	2	3	0	1

Op. cit.

TABLE V

NUMBER AND PERCENTAGE OF PUBLIC HIGH SCHOOLS BY SIZE, 1923, 1934, 1946

	No. of schools	Per cent of Total	No. of schools	Percent of Total	No. of schools	Per cent of Total
Fewer than 50	5,412	36.4	4,609	19.9	3,661	15.3
50 to 99	4,042	26.5	6,159	26.5	5,665	23.6
100 to 199	2,626	17.2	5,594	24.1	5,920	24.7
200 to 499	1,728	11.3	3,660	15.8	5,019	21.0
500 to 999	717	4.5	1,740	7.5	2,212	9.3
1000 or more	614	4.1	1,451	6.2	1,470	6.1
	15,139	100.0	23,213	100.0	23,947	100.0

In 1923, 80.1 per cent of all high schools in the United States had enrollments of less than 200 pupils. By 1946, this percentage had dropped to 60.6. Conversely, an increase of 3,266 small high schools is apparent during this same period. There are 15,246 high schools with enrollments less than 200 in the United States at the present time.

TABLE VI

State Department of Education	Correspondence courses offered
Alabama	No*
California	No*
Connecticut	No
Florida	No*
Idaho	No*
Indiana	No*
Iowa	No
Maine	No
Massachusetts	Yes
Missouri	No*
Rhode Island	No*
Vermont	No*

* Correspondence courses delegated to the State University or some member of the International Correspondence School system.

Only six of the thirteen State Departments of Education contacted, provide means of extending the programs of their small and large high schools. The Massachusetts State Department of Education is the only one having an extension department.

TABLE VII

SCIENCE COURSES OFFERED BY THE INTERNATIONAL CORRESPONDENCE SCHOOLS

General Science -- 13 lessons
Textbook, Everyday Science by Caldwell and Curtis

Biology -- 13 lessons
Textbook, Dynamic Biology Today by Baker Mills

Chemistry, General -- 15 lessons
Chemistry, Inorganic -- 13 lessons
Chemistry, Organic -- 8 lessons

Chemistry -- 4 lessons
Qualitative Analysis. Unless the student has access to a chemical laboratory, he will need a regular qualitative analysis outfit in two parts.

Geology -- 11 lessons
Textbook, Elements of Geology, by William J. Miller

Physics -- 12 lessons
Textbook, Elementary Practical Physics, by Black and Davis

Physiology and Health -- 13 lessons
Textbook, Healthful Living, by Williams

TABLE VIII

SCIENCE COURSES OFFERED BY THE MASSACHUSETTS DEPARTMENT OF EDUCATION

Botany, Parts I and II. -- 10 assignments in each part; one high school unit. Charges: Part I, $9; Part II, $6 (to non-residents, Part I, $13; Part II, $10).

Elementary Biology, Parts I and II. -- 8 assignments in each part; one high school unit. Charges: Part I, $7; Part II, $5 (to non-residents, Part I, $10; Part II, $8).

Elementary Chemistry, Parts I and II. -- 10 assignments in each part; one high school unit. Charges: Part I, $8; Part II, $6 (to non-residents, Part I, $12; Part II, $10).

General Science, Parts I and II. -- 10 assignments in each part; one high school unit. Charges: Part I, $8; Part II, $6 (to non-residents, Part I, $12; Part II, $10).

Physics, Parts I, II, and III. -- 12 assignments in each part; one high school unit. Charges: Part I, $11; Parts II and III, $7.50 each (to non-residents, Part I, $15.50; Parts II and III, $12 each).

Astronomy. -- 10 assignments. Charges: $7 (to non-residents, $11).

CHAPTER III

OBJECTIVES

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OBJECTIVES

The effectiveness of a small school depends upon a clear understanding of the ends which it is expected to attain. For many years, it was the consensus of opinion that the aim of the small school was merely to force specific subject matter into each student as he progressed from year to year. It was believed that emphasis upon those daily presentations adequately prepared the students for life. The effectiveness of the school was determined by the building, the highly trained teachers, the supplies, and equipment on hand. This idea of education was analogous to a mill or factory granting the larger schools definite advantages over the smaller school. Today, we find an entirely different concept of the educational aims. Instead of the emphasis being laid upon subject matter, the trend is to emphasize the child in reference to his needs in this changing democracy.

According to a recent publication,[1] "Science instruction is assigned some part in contributing to the purposes of general education for American youth which are designed to: (1) Equip him to enter an occupation suited to his abilities and offering reasonable opportunity for personal growth and social usefulness; (2) prepare him to assume the full responsibilities of American citizenship; (3) give him a fair chance to exercise his right to the pursuit of happiness; (4) stimulate intellectual curiosity, engender satisfaction in the intellectual achievement, and (5) help him develop an appreciation of the ethical values which should underguide all life in a democratic society."

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[1] Harvard University. General Education for All American Youth. Cambridge: Harvard University Press, 1945.

Many educators have expressed the fact that education should be general for all persons below the college level. This factor is in keeping with the present trends in education.

Science instruction in general education should be characterized mainly by broad integrative elements--the comparison of scientific with other modes of thought, the comparison and contrast of the individual sciences with one another, the relations of science with its own past and with general human history, and of science with problems of human society. These are areas in which science can make a lasting contribution to the general education of all students.

These reports express similar aims inasmuch as the emphasis is placed on the present as well as the future life of the whole child. The present conception considers not only the child as a student within the confines of a building but considers deeply the countless number of factors which influence his environment. In view of the foregoing, the definite advantages of a small school have been uncovered. In a smaller school, greater stress may be placed upon individual differences and instruction. The teachers have much closer contacts with the individual, his interests, his associations, his immediate problems, and his family in communities where schools of this type are located.

However, the problems facing the teacher who seeks in preparing adequately the students for proper adjustments are highly complex. This complexity is manifested by forces bringing about social and economic changes and type of behavior brought forth by each new problem. To fit the real life situation into a classroom problem is practically impossible. The best any teacher can do in this respect is to make as close an approximation of a "real life situation" as is possible. The various areas of the school curriculum should, therefore, rather aim at a set of objectives that will provide for the individual the flexible equipment to face the proper adjustment of life's problems.

The philosophy, methods, and techniques developed in the small school closely resembles those developed in larger high schools. This practice, probably more than any other, is responsible for its many limitations. Imitation of the larger high schools has become one of the smaller school's most serious obstacles. In the matter of building and program construction, this imitation has been very apparent. Certain State Departments of Education have emphatically insisted that the small high schools should not be regarded as a large high school in miniature but as a distinct social agency, which has the responsibility of adapting its subject matter, methods of instruction, and social life to the demands of modern life in its community. They further express

the feeling that small high schools should not set as their goal the accomplishments of the larger high schools.

Briggs[1] makes the following statement regarding the reorganization of schools:

> "It is possible to achieve the functions of high school most fully only if those in charge are willing to abandon their common slavish attempt to imitate the large urban school in organization and administration. In the small school, it is very much easier to make individual programs and to provide intimate personal attendance than it is anywhere else."

The problem of providing a suitable program of studies is difficult in large schools. It is even more difficult in the smaller high schools. The plan of having one instructor serve two or even more schools would be of practical value in such cases. The practice of broadening the curriculum by offering more courses may be effectively rectified by having larger groups placed under the supervision of one teacher.

Unless the objectives actually affect the life of the school, they will have very little value. In order to fulfill the main objectives of education, the Seven Cardinal Principles of Secondary Education[2] should be adhered to by

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[1] Thomas A. Briggs. The Classroom Teacher.

[2] Cardinal Principles of Secondary Education. Report of Commission on Reorganization of Secondary Education, National Education Association. U. S. Office of Education Bulletin, 1918.

teachers at all times:

1. Health
2. Command of fundamental processes
3. Worthy home membership
4. Vocation
5. Citizenship
6. Worthy use of leisure
7. Ethical character

The school must of necessity develop a philosophy which can and will help it to provide a better program.

General and specific objectives must be set up. By general objectives is meant the general ends towards which the school should work. Once established, more specific objectives must be formulated. In the field of science, there would be at least two goals: (1) The general aims which apply throughout the year, and (2) the unit objectives which apply to a single unit during a short space of time. Specimens of units will be found in Chapter IV. A step further would involve more specific objectives under each unit. The aims of each are obviously dependent on the needs of the pupil and the community. These desired needs must be furnished by the school.

As the majority of small high schools are four year schools, a longer period is devoted to the discovery and the meeting of the individual needs than one finds in the larger

three year high schools. Whether large or small, it is the responsibility of the high school to meet the educational needs of all the pupils who attend it. To meet these requirements, the school must meet the needs of pupils planning to continue their education at some college or university as well as those planning to go to work after meeting the high school's requirements for graduation.

Whether pupils are planning to finish school or not, certain contacts with these educational needs must be made by them. Assuming responsibilities, knowledge of their own strengths and weaknesses, understanding of health problems, an appreciation of democratic living, an appreciation of art, a worthy use of leisure time, and a continuation of self-education are but a few of the educational needs which all pupils must have before ending their formal education.

Opportunities to assume responsibilities and leadership must be given all students. The practice of democratic living may be carried on in the classroom or elsewhere in the school building under the proper guidance of more experienced and mature teachers. This teacher-pupil cooperation tends to place a greater responsibility of true democratic principles "squarely on the shoulders" of those participating. This practice would bring forth the pupil's obligations to others; it would allow him to express himself and display certain characteristics of leadership and most certainly grant an opportunity to display the favorable trait of self-

control. He may participate in home room activities, in assemblies, in proctoring study halls, classrooms, and tests, in taking an active part in student government affairs, leading an athletic team, and many other similar activities.

The great influx of youth into the high school, the greater emphasis on the individual pupil and his particular needs, and the resulting broadening and enrichment of the curriculum have all increased the need for pupil guidance. Sound guidance while in school is very essential in that it brings to the pupil his own abilities as well as his needs. Relative strengths and weaknesses should be well understood by each individual. A pupil aware of his weaknesses may strive to rise above or overcome them; his strengths may assist him in discovering his place in life and in adjusting himself to it. A sympathetic understanding and the proper advice of parents on the one hand and teachers or counselors on the other are definite needs in helping of students to make their post-school adjustments.

Schools are now obligated to educate their pupils physically as well as mentally. The importance of the pupil's physical condition and health can not be overemphasized by any school. The following excerpt dramatizing knowledge already known but not acted upon, illustrates a condition prior to World War II:1/

1/ American Association of School Administrators, Sixteenth Yearbook, Youth Education Today pp. 37-38. Washington, National Education Association, 1938

> "At least 22 per cent of the pupils in high school suffer from malnutrition, tuberculosis, eye and teeth defects, or some other imperfection which could be remedied or actually corrected if care were available. Of the school children examined in six selected cities, 65 to 95 per cent had defects of some seriousness; 33 per cent had diseased tonsils; 34 per cent, defective vision; and 50 per cent, defective teeth. When the Life Extension Institute examined 100,000 young men, three out of four were found to be physically defective. Modern youth may have inherited health, but in many cases the estate has not been settled."

The recent war revealed an appalling condition regarding the health of the average soldier. The result was greater emphasis on physical fitness by the armed forces. In turn, a new appreciation of the needs for provisions of physical education and health training has been brought into the schools. Good health habits are as much a part of the equipment for life as are good habits and attitudes in science and mathematics.

Pupils need to understand and appreciate democracy as the American way of life. To participate and practice the principles of democracy both as an individual and as a member of a group are important phases of everyday school life. Boys and girls must be educated to work and live together more successfully to the changing conditions of our civilization. Failure to understand many of our current problems has led to breakdowns in our current civilization. Only through a complete understanding and cooperation of the home, church, the school, the community, the state, the nation, and the world will we enjoy peace and the more noble attributes of a true democratic nation. To practice and contribute to

democracy is an important need of all pupils today.

They need to recognize and appreciate the aesthetic qualities which surrounds them. The appreciation of art, nature, literature, and music must be brought to their attention. They must learn how to adapt artistic quality and beauty to their own uses. Boys and girls must be taught to love their neighbors regardless of race, color, or creed. They must learn to appreciate the acceptable as well as good qualities of their associates. Encouragement to aim at high quality in the art of living is a definite need of all.

To secure wholesome recreation and relaxation through games, sports, travel, good literature, the fine arts, conversation, and hobbies is another important need of all youth. Pupils are encouraged to explore a wide range of leisure-time pursuits, to develop skills and other forms of ability in leisure-time occupations, and to develop a respect for the ideal of safety, and learn methods of promoting safety in leisure-time pursuits in the home, on the street, and in the forest and open country. All youth must be able to use its leisure time well and to budget it wisely.

Pupils must learn the values of self-education. Whether they finish their formal education during their high school days or continue their education in some college or university, they need to grow in their ability to think rationally, to express their thoughts clearly, and to read and listen with understanding. They should learn to think for them-

selves and look at the merits involved in any case before rushing into any uncritical or unsound decision. Most certainly they should be encouraged to study and to learn after they leave school.

Whether a student is pursuing a correspondence course in school in conjunction with his other work or out of school with his regular employment, the aforementioned aims may well be met through this program. The student attaining a formal education by regular attendance at school is confronted with these aims daily. The ambitious individual seeking a higher standard of living but being deprived of the benefits of a formal education is not deprived of the major educational aims. As a general rule, his main objective is to improve in order that he may become more efficient in his chosen vocation and reach a higher level of living. In proceeding with his correspondence program, his character is most definitely improved. While thoroughly mastering each lesson, he must express himself clearly and exactly which has a precise value in all walks of life. The self-confidence secured through the process of utilizing leisure moments for definite vocational or professional advancement is most certainly in keeping with the aims of education.

CHAPTER IV

SCIENTIFIC METHOD

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SCIENTIFIC METHOD

Of all the methods that have been proposed for use in the secondary school, one method must have first consideration in the teaching of science, namely, the scientific method. When considering the individual differences, the science offerings, and the heterogenous groupings found in a small school, one must also consider the unit method. An application of these two methods should adequately prepare the college as well as the non-college student for the future. These methods in conjunction with correspondence courses, enriched reading materials, audiovisual aids, and the general school equipment should furnish the small school student with adequate preparation for most any college or university. The application of the scientific method is a matter of securing the correct explanation or finding the best explanation within the comprehension of the students. Today, students discover new facts for mankind as well as for themselves. They must do the latter day by day if they are to become fully equipped for the age in which they live.

The scientific method is a good way to solve many kinds of problems of everyday life. It begins with a problem. The problem may be any question for which pupils do not know the answer. The first step is to have them orient themselves to a problem or a question. The problem should then be clearly

defined. The relation of facts and possible answers to the problem must then be studied and given deep thought. Once a right answer has been selected, an experiment should then be carefully planned to check the answer. From this experiment, definite conclusions can be drawn. There are many problems in science which are sufficiently within the comprehension of pupils to provide them with ample opportunity for generalization and for drawing conclusions. Pupils must learn that they cannot gain truth through discussion alone; nor can they be certain that the conclusions they themselves draw from experiments are infallible. A comparison of their conclusions against contributions made by leaders in the field of science must be impressed upon them before they make any final decisions.

THE UNIT METHOD

The unit method which provides for individual differences and places emphasis upon pupil activity rather than teacher activity most certainly has its place in any type of learning. Whether in school or at home, this method is well adapted to the slow pupil and challenges the bright pupil. It assures greater individual effort and participation. It involves problem solving both from an intrinsic and extrinsic standpoint. It makes allowances for the different levels of intelligence, the different aims and attitudes encountered, and the general over-all plans for the development of each pupil. It's a method pupils prefer.

The correct use of the term method as applied to teaching and learning has been a controversial issue for a long time. In planning and organizing daily classroom activities, a teacher may apply any one or a combination of two or more of the following teaching methods: laboratory plan, problem method, differentiated assignments, contract plan, project curriculum, and individualized instruction. In practice, these methods differ only in name. No uniformity of practice exists in any of the groups. However, the variability of practice in any one of the groups is essentially the same in kind and degree as the variability in any other group. It is reasonable to conclude that many teachers have abandoned the special techniques and methods that many would specify, at least theoretically, for a particular type and have had in mind a central unifying idea about which work has been planned as a unit to meet the needs of the learner. Due to the fundamental similarities of the above mentioned methods, the term "unit assignment" has been adopted to cover them all.

In teaching, the daily-lesson plan can be used with any plan of course organization, but it is most frequently used with courses organized by topics, especially where the textbook is used as the basis for most of the work of the course. Where courses are organized as a series of problems, projects, or units, some "unit" plan of organizing activities is especially adapted to planning the day by day work. Both classroom and directed home study fall in this category.

However, many teachers still plan daily lessons to be learned and give little attention to unit planning and the important problems related to it. Nevertheless, to acquire certain understandings and abilities, some pupils require a longer period of learning than a daily class period. This advances another apparent relationship between the teacher-directed unit method and the self-directed home study in the matter of individual differences. Students in both of these methods receive individual attention regardless of their rate of progress and the progress of other students. They can start with the study of any subject and proceed as rapidly as their ability, study time, and application will permit. The responsibility of successfully completing either rests with the individual student. Teachers can encourage pupils to study, help them when they need help, test their mastery of the subjects and help them make use of what they learn, but nobody can learn for the students but the students themselves.

As this central unifying idea applies to all classroom instruction and learning, it is reasonable to assume that it also applies to all instruction and learning at home. In this connection, the unit idea is more closely associated with correspondence courses than any other method. Both unit assignments and correspondence courses are "contracts" in a sense agreed on by pupil and teacher. Both consist of a variety of requirements or activities; namely, topics to be studied, reports to be made, papers to be written, problems

and exercises to be worked, and projects to be carried out.

In the unit method, the teacher gets all material ready in advance, sets a certain number of days in which the unit is to be completed, helps pupils with their difficulties, checks the progress each pupil is making, assist pupils with experiments in science, keeps a record of difficulties pupils are having, and gives a test to pupils who have completed a unit. The correspondence study operates in a similar manner inasmuch as the instructor mails text materials and pamphlets covering the first lesson, answers students' inquiries and help them with their special problems, checks the progress of each pupil by withholding the grade of a lesson until successfully completed, keeps records of texts, lessons, and grades, and administers an examination each time a lesson is completed.

In the case of the unit method, the teacher is present; in the case of the correspondence courses, the teacher is absent. However, each correspondence class is conducted in the same manner as a good unit organized group. Each student is under the direction and guidance of a qualified instructor in the subjects taught although he may be many miles away. The student spends a definite portion of each class hour on each of the different subjects being studied. In other words, it is conducted like a good "unit" in the regular classroom except that correspondence texts and instruction service are used in conjunction with the resident

instruction under the direction of a local teacher.

Whether in the classroom or at home, three kinds of instruction are available to all students; namely, (1) pure correspondence courses, (2) pure resident instruction, or (3) a combination of the two. In addition to the regular academic courses found in the majority of secondary schools, students pursuing correspondence courses are offered a variety of vocational and technical courses of study. They are also able to progress individually and with greater speed than in a regular class group. In a certain sense, flexibility of this service makes it superior to classroom instruction alone.

Whereas both the unit method and the correspondence courses are contracts, both consist of a variety of requirements, and both provide for individual differences, samples of each have been incorporated in this work. Specimen units in the four traditional science courses follow; sample correspondence courses offered by the Massachusetts State Department of Education will be found on pages 91 and 92. A close scrutiny of these specimens and the sample correspondence courses will reveal the close link which exist between these two. Probably more than any methods, these two go hand in hand.

GENERAL SCIENCE

A. Unit organization of the topic Water.

The Unit: Water is essential to all life. Animal life and vegetable life are fully as dependent upon water as is human life. Deserts which are found in many countries are practically uninhabited because life is scarce when water is scarce.

The Delimitation of the Unit:

1. Next to air, water is the most necessary factor of our environment from the standpoint of our immediate needs.
2. History reveals that aqueducts were constructed to help furnish Rome with its water supply.
   a. Thousands of years ago, prior to setting out on a caravan, the filling of water bags with the precious fluid received top priority.
3. Living things must obtain water.
   a. Plants and animals are made up of millions of units called cells.
   b. Water to a large extent is the material of which the cells are made.
   c. The blood, which is itself mostly water, carries digested food to every cell in our bodies.
   d. Water helps to rid the cells of waste matter.
4. Water may exist in any one of three physical states.
5. The weather is dependent on the amount of water (vapor) in the air.

   a. The higher the temperature of air, the more moisture it can hold.
   b. Evaporation is always going on whenever there is water in liquid form.
   c. Particles of water continue to travel in a "coaster cycle".
6. Water is essential to the community.
   a. There must be enough good water for every citizen every day.
   b. The purification of water is an important problem of all communities.
7. Water is necessary for many purposes.
   a. Water is used in heating systems, in the steam engines that propel ships and trains and in those that run machinery in factories.
   b. Water power often makes electricity.
   c. The distribution of water for each of its many uses through water mains and pipes, if done by means of water pressure.
8. The average amount of water used by every single person in the whole country is thirty-five gallons each day.
9. The very lives of more than a million people in far west depend on irrigation.
   a. Irrigation has brought life to many parched lands.
   b. Most irrigation projects depend upon hills or mountains in the vicinity.

10. Water has been instrumental in uniting all nations of the world.
    a. Navigation over these water highways has played a very important part in the foundation of a civilized world.

The Unit Assignment (tentative time allotment, three weeks, five periods per week.)

B. Introducing a class discussion about the importance of water. The discussion is centered around such questions as:

(1) How do we get the water we need? (2) Do all living things contain water? (3) How do plants obtain and use water? (4) How is water made fit for drinking purposes? (5) Of what use is water made in transportation? (6) What is water pressure and how may it be put to work?

C. For individual study and investigation:[1]

1. What is water? How can it be prepared?
2. Since hydrogen and oxygen support combustion, why does water, a compound of hydrogen and oxygen, not burn?
3. How does rain get into the sky?
4. What is water pressure?
5. How is water used in our homes?
6. How is water used to carry waste from our homes?

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[1] Each pupil would receive a mimeograph form of items listed under C.

7. How do towns and cities secure an ample supply of water?
8. How may a community safeguard its water supply?
9. How do we use water in our work?
10. Of what use is water made in transportation?
11. What have forests to do with water supply?

D. Optional related activities.

1. Oral reports on some prepared topic or personal experience.
    a. Collect pictures showing fertile fields which were once desert land.
    b. Tell of a visit to a purification plant.
    c. Discuss the possibilities of putting to work some lake or stream near your home.
    d. Discuss the growth of your community and the work of its people by a nearby source of water.
    e. Name some of the work projects taken by the government in recent years to make water work for us.
    f. How much money is spent yearly for the purpose of securing a safe water supply for your community?
    g. Why is sewerage disposal important with a safe water supply?
    h. Why is water obtained from deep wells usually free from bacteria?
    i. Is it possible that some of the water which is in your body was once in the body of some other person,

plant, or animal? Explain.

2. Written report of some prepared topic or personal experience:
    a. Make a report of some community which gets its water from a river.
    b. Report on the enforcement of laws against pollution of rivers and streams in your community.
    c. During a rain, observe the water flowing along the gutter. Trace this water in its course and tell all that might happen to it on its way to the ocean.
    d. Compare the rates of evaporation of water, alcohol, gasoline, kerosene, and carbon tetrachloride.
    e. Prepare a chart showing the uses of five important elements.
    f. Tell why hydrogen has been replaced by helium for use in ballons and their lighter-than-air craft?
    g. Explain how hydrogen is utilized in the manufacture of ammonia and fertilizer.
    h. Keep a record of the number of glasses of water you drink each day for one month.
    i. Construct a chart showing the percentage of water in eggs, milk, white bread, oats, corn, meat, and fish.
    j. In what way are desert plants well adapted for conserving water?

- k. Tell why a camel is able to travel long distances without water.

3. Drawing:
    - a. Draw a model of a filtration plant.
    - b. Draw a map showing how your community gets its drinking water.
    - c. Draw a map of the United States indicating the varying amounts of rain fall in the different areas.
    - d. Draw a map showing in color where floods have occurred. Compare the flood section with the forest section.
4. Collection and exhibits:
    - a. Make a collection of animals and insects which live in waters about your community.
    - b. Construct a model purification plant.
    - c. Build a model of a dry dock.
    - d. Collect pictures of the five largest ocean liners in the world.
    - e. Collect pictures of several types of submarines.
    - f. Prepare a list of substances that float in water. Make another list of substances that sink in water.
    - g. Collect photographs of old mills showing types of water wheels now little used.
    - h. Construct and operate an overshot wheel.
    - i. Construct and operate an undershot wheel.

Boston University
School of Education
Library

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4. Samuel R. Powers, and Elsie Flint Neimer, Our World and Science, Boston: Ginn and Company, 1941
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BIOLOGY

A. Unit organization of the topic on the Behavior of Plants and Animals.

The Unit: Although a majority of the people can think of plants only in terms of stationary and unresponsive organisms, it must be realized that certain similarities exist between them and the more complex and active animal organisms. The slow simple plant reactions are overshadowed by the more rapid reactions of the animal complexities. Regardless of the type organisms encountered--

plant or animals--both react to stimuli in their environments. The superiority of man over other forms of life is just as evident in his various forms of behavior.

The Delimitation of the Unit:

1. Man is characterized by his every move.
2. ✓ Both plants and animals respond to changes occurring in their environment.
3. The behavior of living things is closely related to the kind of stimuli to which they can respond.
4. Man differs in his behavior from other living things.
5. The behavior of animals is controlled by a nervous mechanism.
6. The nervous mechanism reaches its greatest complexity in man.
7. The five senses of seeing, hearing, feeling, taste and smell keeps man in touch with the world about him.

The Unit Assignment (tentative time allotment, three weeks, five periods per week.)

B. For individual study and investigation.

1. To what kinds of stimuli do living things respond?
2. How do plants respond to light?
3. List as many human reflexes as you can. How do you know they are reflexes?
4. Can you give an example of a conditioned reflex in a child?

5. How are roots of plants pulled downward?
6. How do plants respond to heat?
7. What are the chief characteristics of simple reflexes.
8. Compare reflexes with instinctive behavior.
9. How does intelligent behavior differ from instinctive behavior and reflexes?
10. Explain the difference between memory and reasoning.
11. How do the nervous systems of man compare with those of the lower forms of animals?
12. What are the important functions of the human nervous system?
13. What are the important parts of the nervous system?
14. List and explain the three types of nerves.
15. What is intelligence and how is it measured?
16. List and explain the functioning of the five senses organs.
17. How does each of the leading parts of the nervous system function?
18. What three primary factors make up the original nature of man? Give examples of each.
19. Is a person with a large brain necessarily more intelligent than one with a small one? Why or why not.

C. Optional related activities.

1. Oral reports on some prepared topic or personal experience.

a. Why are animals capable of a greater variety of responses than are plants?

b. Soldiers have had legs and arms amputated and have complained of pains in the missing leg or arm. Is this possible. Explain?

c. Of what value are intelligence tests?

d. Why should potted plants which are kept near a window be turned around every few days?

e. Observe one of your pets. What responses does it make which are apparently instinctive?

f. Tell why a stimulus received by a single sense organ would involve a large part of the body in a short time.

2. Written report of some prepared topic or personal experience:

a. Describe the experience which you have had in learning to ride a bicycle or roller skate. Was it "trial and error" learning or did you reason out the method and then do it?

b. Prepare a report on the "Instincts of the Social Insects."

c. Prepare a report on the sense organs of different animals.

d. How do animals make worthy use of tools?

e. Compare home building methods among the members of the animal kingdom.

   - f. Write a report on the level of behavior of an animal as compared to the type of nervous system he has.
   - g. Why do responses of one animal differ from that of another?
   - h. Write a paragraph on the craftiness found in animals.
   - i. Look up and report on color perception in bees.
   - j. Give examples to show that man is inferior to some mammals in his senses and muscular control.
   - k. Show that some tropism is of value to a plant, to an animal.
   - l. Explain fully how your leg is adapted to its uses.

3. Drawing:
   - a. Draw sketches of the sensory structures of animals.
   - b. Draw diagrams of the eye and the pin hole camera showing the manner in which light enters both.
   - c. Draw a diagram of the ear labeling the essential parts.
   - d. Draw a diagram of a nerve showing the path of an impulse from a neuron across a synapse.
   - e. Draw a diagram of the nervous system of man.
   - f. Draw a diagram of the human brain labeling each part.
4. Collections and exhibits:
   - a. Prepare a collection of animals found in your locality.

b. Prepare a scrapbook of pictures taken from papers, magazines and other publications illustrating various forms of animal behavior.

c. Prepare slides of nerve tissue for microscopic study.

d. Prepare a simple model to show afferent, efferent, and transmitting neurosis.

e. Prepare a puzzle box to show the "trial and error" method of learning in a cat or dog or some other pet.

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CHEMISTRY

A. Unit organization of the topic Oxygen.

The Delimitation of the Unit:

1. In 1774, an English scientist by the name of Priestly discovered that by heating the powder, mercuric oxide, the powder would disappear and a gas would take its place.
2. If all the atmosphere were as dense as that near the earth, there would be less than five miles of atmosphere surrounding the earth. If the various substances in this atmosphere were placed in layers one above the other, there would be about 5,000 feet of oxygen.
3. Oxygen is eight-ninths of the weight of pure water.
4. One-quarter to one-half of the weight of rocks is oxygen.
5. Furniture, clothes, automobiles, houses and practically everything else contains oxygen.
6. Oxygen is essential to all life.
7. Oxygen is one of the three or four chemical elements that play the most important parts in the life of human beings.
8. The cooking of our food, the heating of our homes, and the development of mechanical power depend upon oxygen.
9. Oxygen has a great tendency to combine with other elements.

10. Ordinary burning is oxidation accompanied by noticeable light and heat.
11. Slow oxidation is the combination of a substance with oxygen without noticeable light and heat.
12. Spontaneous combustion, the cause of many household fires, is an active burning started by the accumulation of the heat of a slow oxidation.
13. Pure oxygen is sometimes administered in place of air to persons who are sick.
    a. Usually in cases of pneumonia, some heart attacks, and asphyxiation.
14. Very high temperatures are obtained with oxyhydrogen and oxzcetylene flames.
15. Oxygen in combination with nitrogen (laughing gas) is used in minor surgical operations.
16. Many substances called oxides are always produced by the process of oxidation.

B. For individual study and investigation.

1. What is oxidation and how is it controlled?
2. Do living things burn?
3. State facts to prove the great abundance of oxygen in nature.
4. How did Priestly prepare oxygen?
5. How is oxygen prepared in the laboratory?
6. What is the most noticeable chemical property of oxygen?
7. What is meant by the term oxide?

8. What is the simplest method for checking a fire in a stove?
9. Why does stepping on a match put it out?
10. Why will blowing a smoldering fire often make it burst into flame?
11. In what three ways are ordinary burning and combustion alike?
12. Why do substances burn more vigorously in pure oxygen than in air?
13. In what two respects is the slow oxidation of a substance like its burning? In what two ways is it different?
14. How do wood, phosphorus, and iron differ in their kindling temperature?
15. State what conditions must exist to cause spontaneous combustion either of coal dust in bunkers or of rags used for wiping paint.
16. How is the supply of gas to a Bunsen burner regulated? The supply of air?
17. What effect does the pressure of the gas have upon the air supply to the flame?
18. Trace the course of oxygen in the human body from the time that it is breathed in until it is expelled as a part of carbon dioxide?
19. How do plants use the carbon dioxide expelled by animals? To what extent do plants use oxygen?

20. Select five different uses of oxygen and state what property each use depends.
21. When and why is oxygen especially used by (a) life-guards, (b) firemen, (c) hospitals.
22. What is the advantage of the oxyhydrogen flame? In what ways is this flame put to practical use?
23. Why does throwing a blanket or rug around a person whose clothes have caught fire extinguish the flame?
24. Why is water usually ineffective in extinguishing burning oil?
25. Why are metal containers provided for the oily wastes in carpenter shops and automobile garages?
26. Explain the successive use of paper, wood, and coal in making a fire.
27. Why does a newspaper burn so rapidly while a book or magazine burns very slowly?
28. Dust explosions are unexpected happenings. May they be classed as spontaneous combustion? Explain.
29. Why may a spark in a flour mill produce an explosion?
30. What are the products of ordinary burning? To what general class of compounds do they belong.
31. What is a catalyst?
32. What is meant by kindling temperatures?
33. What makes ozone in the upper air?
34. What are the properties and uses of ozone?
35. (a) Can you tell from the looks of a compound whether

it contains oxygen? (b) Give two examples which prove your answer correct.

36. What chemical action is prevented by painting houses and metal structures such as iron bridges?
37. What are the practical uses of oxygen?
38. What energy takes place in burning? What practical uses in daily living are made of this change?
39. What is the fundamental difference between substances like oxygen, sulfur, and iron, and those of water, oxides and iron sulfide?
40. Describe an experiment which gives evidence as to the amount of oxygen in the air?
41. What is electrolysis of water? What does it produce?
42. What is the purpose of the oxygen that animals breathe?
43. Why would fuels be useless if there were no oxygen in the air?
44. Would vegetables decay in a vacuum? Explain.
45. What is the relation between oxygen and the cutting or welding of metals?
46. Explain the relationship between oxidation and combustion.
47. What is meant by the kindling point of a substance?
48. Why is oxone sometimes used to do the work of ordinary oxygen?

C. Optional related activities.

1. Oral reports on some prepared topic or personal experience.
   a. Study and report upon as many examples of slow oxidation as you can observe in a week.
   b. Summarize for the class the work of Priestly in preparing oxygen.
   c. More than 200 years before Priestly, it was written "Animals cannot live where flames cannot live." What does this statement mean?
   d. Report upon the causes of fires which have occurred recently in your community.
   e. Report to the class on the function and use of an oxygen tent.
   f. Suggest different methods for putting out fires and tell how each would act.
   g. Can you find uses of oxygen not indicated in this unit? Report on them in class.
   h. Why do some cities spray into the air water that is to be used for drinking?
2. Written report on some prepared topic or personal experience.
   a. Observe and report upon ten physical and ten chemical changes which take place about you during a period of four days.

- b. Make a study of the best methods in use today to stop slow oxidation and report upon them.
- c. When feeling "dopey" will breathing more oxygen make you more "alive"? Think it over and then write your new points on the subject.
- d. Check with your fire chief and report in writing all cases of spontaneous combustion which have occurred in your community during the past ten years.
- e. Write a brief biographical sketch of either Priestly or Lavoisier. (Consult an encyclopedia).
- f. How is oxygen used in reviving an asphyxiated person?
- g. Of what benefit is oxygen to pneumonia sufferers?

3. Drawings
   - a. Draw the apparatus that serves best in the preparation of oxygen in the laboratory.
   - b. A sketch of a home made fire extinguisher.
   - c. Draw a diagram of an oxyacetylene blow pipe.
   - d. Draw a simplified diagram showing the method used in liquifying air.
   - e. Draw a diagram and label the essential parts of a Bunsen Burner.
   - f. Draw a simple apparatus for the electrolysis of water.
   - g. Draw a simple diagram of the oxidation of iron filings.

4. Collections and exhibits
    a. Various experiments for the preparation of oxygen.
    b. A chart or scrap book of different types of fire fighting equipment.
    c. Oxygen masks used by firemen and aviators.
5. Experiments
    a. A study of Burning--to discover what happens during burning.
    b. Oxygen--to discover how oxygen can be prepared and studied in the laboratory.
    c. Behavior of oxygen--to determine the chief properties of the life-giving gas we breathe.
    d. Nature of slow oxidation and spontaneous combustion.

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PHYSICS

A. Unit organization of the topic Light.

The Unit: The Sun is the source of all energy. Light, which is a form of energy, is an important factor in our daily living. Without it man as a race could not exist. Work, pleasure, and all men's activities are made possible by this phenomena. Throughout the years, man has been able to use and control it.

The Delimitation of the Unit:

1. Light is a form of energy brought to us by waves which have their source in the sun.
2. Light from the sun warms the earth or enables green plants to manufacture food.
3. Light is concerned with bringing rain which is so necessary to life.

4. Light enables us to see.
5. Most objects are visible to us by reflected light.
6. Light energy is used in communication.
    a. Electric signs give all sorts of directions, warnings and information.
    b. The beams of light from lighthouses and beacons help to guide ships at sea.
7. Light rays can be controlled and directed by the use of prisms, lenses, and different kinds of surfaces.
8. Eyes should be protected from too much or too little light.
9. By modern devices, artificial light is produced and can be distributed so that the eye uses it to the best advantage and without injury.
10. The camera and the eye are built on the same principle.
    a. Defects of the eye should be rectified by glasses.
11. Indirect lighting is a great aid to eyes.
12. Light is indispensable to life.
13. Shadows are formed when light strikes opaque objects.
14. By use of a prism, white light may be broken up into its component colors.

The Unit Assignment: The Unit opens with four simple demonstrations: (1) to show by means of shadows that light travels in a straight line; (2) to show by use of a prism; (3) to show by comparison that light waves change to heat waves when striking an opaque object, and (4) to show that

light waves may be reflected from a certain surface.

B. Introduction: A class discussion on light.

The discussion is centered about such questions as: (1) What is it that helps us see everything about us? (2) Is this thing called light instantaneous? (3) What would happen if light was taken away from us? (4) Does light have anything to do with the formation of rainbows? and (5) How far does light have to travel before reaching the earth?

C. For individual study and investigation:

1. What is the source of all light?
2. What causes a spectrum?
3. Why is light bent as it passes through a prism?
4. What different colors absorb light? reflect light?
5. Name two theories of light and give the names of the physicists who advanced them.
6. How do light waves differ from (a) sound waves, (b) heat waves?
7. Distinguish between candle power and foot-candle.
8. Name five kinds of electromagnetic waves.
9. Does light travel in a straight line?
10. Why does an object appear upside down in the back of a camera?
11. What effect would be produced on a pinhole camera image by making the aperture larger?

12. Give the steps and the reasoning involved in the first determination of the velocity of light.
13. State five facts about a plane mirror image.
14. What difference exists between real and virtual images.
15. Explain the formation of multiple images.
16. Compare convex and concave mirrors as to effect upon light waves, kind of images formed and uses.
17. Should the basement of your house be painted black inside or whitewashed? Why?
18. Should book paper, wallpaper, and painted surfaces for interiors be rough or smooth? Why?
19. The image formed on the retina of the human eye is inverted. How do you account for the fact objects appear right side up?
20. Why are lantern slides inserted into the projector upside down?
21. Why is a moving picture not really a moving picture?
22. Describe the image formed by a convex lens placed less than its focal length from an object.
23. Where must an object be placed with reference to the focus and the center of curvature of a spherical mirror in order that the image be real and (a) larger than the object? (b) smaller than the object?
24. In what two positions with reference to spherical

mirrors may an object be placed so that the image is vertical?

25. Name the parts of the eye and state the use of each part.

26. Where is the eye lens? How does it accomodate itself to varying object positions?

27. What is the reason for nearsightedness? What kind of lens relieves it? What kind of lens is used for farsightedness?

28. Distinguish between spherical and chromatic aberation.

29. What is the difference in construction between a simple and a compound microscope? What is the difference in their images?

30. Explain the relation between total reflection and the brilliance of gems.

31. Problems:

    a. A camera lens has a 6 inch focus. How far from the lens must the plate be in order to obtain a clear image of a person standing twelve feet from the camera?

    b. If the focal length of a spherical mirror is 5 inches, what is the area of the sphere of which the mirror is part?

    c. An object 8 inches in height is placed on the principal axis of a convex lens at a distance of 4 feet from the optical center. The focal length

of the lens is 25 inches. How far is the image from the lens?

d. A boy 5 feet tall stands 12 feet from a camera lens. His image appears 7 inches from the lens. What is the focal length of the lens? What is the length of the image on the plate?

e. Find the final length of a lens that at a distance of 5 inches forms an image of an object whose distance is 40 inches from the lens.

f. A pupil experimenting with a lens finds that it will form an image at 60 cm. of an object at 24 cm. What is the focal length of the lens?

g. What would be the intensity of illumination on a book placed 6 feet from a 50-cp lamp? What distance from the lamp will the illumination be four times as much?

32. Distinguish between light and illumination. What is the use of measurement of illumination?

33. State the law showing the relation between distance and illumination.

34. Give two ways by which a number of foot candles of illumination on a desk could be increased.

35. Explain how a photometer may be used to measure candle power.

36. What is the distinction between a photometer and a foot-candle meter?

37. What is the law of Inverse squares?
38. Describe an experiment by which the dispersion of light can be shown. What is the visible result of dispersion?
39. What is a spectrum? Describe the spectrum of white light.
40. Explain how the following color sensations are produced: red, white, green, yellow, blue, purple.
41. A color top has its upper surface painted in sectors of different spectrum colors. What appearance should the top have while spinning? Explain.
42. Show how white, red, purple, and black surfaces differ in their ability to reflect and absorb light.
43. White light is dispersed and passed through red glass. What color will appear on a screen beyond the glass?
44. Compare the characteristics of light and sound waves.
45. Under different circumstances, light may be diffused diverged, or dispersed. Distinguish between the three phenomena and name an object associated with each of them.

D. Optional related activities.

1. Oral reports on some prepared topic or personal experience.
   a. Define and illustrate (a) luminous body, (b) transparent body (c) opaque body.

   - b. What causes mirages? What causes the familiar mirage on an automobile highway on a hot day?
   - c. What causes the color at sunset and sunrise?
   - d. How are farsightedness and nearsightedness corrected?
   - e. Archimedes is said to have set fire to enemy ships by means of mirrors. Tell this story in detail.
   - f. Tell the story of the 200 inch reflecting telescope.
   - g. Report to the class on the meaning of the unit foot-candle.
   - h. Explain why it is easier to drive an automobile at night with no light on in the car.

2. Written report on some prepared topic or personal experience.
   - a. Report on the influence of colored glass and other special kinds of glass in affecting light in aquaria, homes.
   - b. Report on the microscope made by Van Leeuwenhoek and upon some of the discoveries he made with it.
   - c. Report on the early history of photography.
   - d. Report on the amount of the energy of the sun that reaches the earth.
   - e. Report on the advantage of human beings having two eyes instead of one.
   - f. Tell why it is difficult at night to see outdoor objects through a window from a lighted room.

g. Tell of the life of Thomas Edison.

h. Report to the class of a survey made of the street lighting plan of your hometown.

i. Make a report on new types of lighting.

j. Make a report on how to read ordinary household meters, including electric, gas, and water.

3. Drawing:

a. Draw a diagram of a glass prism breaking up a ray of light into its component colors.

b. Draw a diagram of rays striking a smooth surface; rough surface.

c. Draw a diagram of the human eye.

d. Draw a diagram showing or expressing refraction.

e. Draw diagrams of different lenses showing what happens to rays of light in each case.

f. Draw a diagram of a shadow showing the important parts.

g. Make a drawing to illustrate (a) regular reflection, (b) diffused reflection.

h. By means of a diagram explain (a) angle of incidence, (b) angle of refraction (c) angle of deviation.

j. Make three sketches of abnormalities of the human eye (a) far sightedness, (b) near sightedness, (c) astigmatism.

4. Charts, maps and photographs.
   a. Collect photographs of some of the greatest telescopes in the world.
   b. Make a chart of a household light meter.
5. Collections and Exhibits
   a. Construct a periscope.
   b. Construct a microscope and a telescope.
   c. Pin hole camera.
   d. Construct a miniature of your school house.
6. Experiments.
   a. Law of reflection--to find how light is reflected from a plain mirror.
   b. Image in a plain mirror--to compare an object with its image produced by a plain mirror.
   c. Index of refraction--to find the index of refraction of glass.
   d. Focal length and Real Images--to find the focal length of a converging lens and to study the images which the lens forms.
   e. Conjugate Foci of a converging lens--to find the relation of conjugate foci to each other and to the principal focus.
   f. The telescope and microscope--to construct and study a simple telescope and microscope.

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CHAPTER V

SUMMARY AND CONCLUSIONS

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Even though a pupil in a small high school is confronted with a limited program of studies and a corps of teachers numbered between two and ten, it is possible for him to be every bit as adequately prepared to take his place in the community or the world and in a higher institution of learning as his brother in the larger high school. Many agencies and methods are available to aid him in overcoming the limitations of the local offering. In 1946, nearly two-thirds of the high schools in the U. S. had enrollments of 200 or less. In the state of Massachusetts, at the present time, there are 101 high schools in this category. Of this number, nine schools have an enrollment of less than fifty. Every one of them teaches at least one of the traditional science courses; only sixty-two teach all four. This is indicative of the limitations of other fields facing the small high school pupils in the state of Massachusetts as well as other small school pupils throughout the United States.

Correspondence courses offered by State Departments of Education, Universities and Colleges, and the thirty-nine International Correspondence Schools, alternation of subjects, consolidation of schools, out-of-school Work, attending summer school sessions, and the use of circuit teachers appear

to be the best methods of expanding curriculum offerings in small schools.

Apparently, the most common, popular, and economical method devised to date in meeting the needs of individual pupils in small high schools is that of supervised correspondence study. In order to become active in this program, whether it is with the International Correspondence School or a State Department of Education, a student enrolls in a course signing a formal application which specifies what he wishes to study and sets forth in detail the conditions under which he and the school agree to work for his education. When this application is accepted, it becomes a contract. A notice of acceptance is then mailed to the applicant, together with a formal letter of welcome and other publications that tell him how to proceed with his work as a student. Study text materials for his first lesson are also sent to him.

In preparing the average correspondence course lesson for which there is a written examination, the student studies an instruction paper, or pamphlet text, and then receives a set of examination questions.

Instructions to students usually include the following:

1. Study the text thoroughly before attempting to answer the questions.

2. Read each question carefully and be sure it is well understood; then write the best answer.

3. When answers are completed, examine them closely; correct all the errors found; and see that every question is answered; then mail work to the correspondence school.

Upon receipt, the school corrects and grades students' lessons, and prepares many special letters to answer students' inquiries and to help them with their special problems. Lessons are then graded according to the marking system of the school concerned. If the work on a lesson shows need of more study, the grade is withheld; and the student is told what to study and what additional work to submit. Only when corrected work proves his understanding or his skill to be adequate is a student permitted to consider the lesson completed. Records show when and what texts were sent to the student, when each lesson was received and returned, the grade given, and who corrected it as well as all other information needed.

The International Correspondence Schools offer a complete high school general, academic, and business schedule. Inasmuch as they serve individual needs of pupils, this supervised correspondence study is a promising potential source for the enrichment of the offerings of a small school. They are conducted in a manner similar to any regular high school They offer classes in most every conceivable subject. Each group is under the guidance and direction of a qualified instructor in the subjects taught. The group spends a definite portion of each class hour on each of the different

subjects being studied. In other words, it is conducted like the regular method except the International Correspondence Schools' texts and instruction service are used in conjunction with the resident instruction. Flexibility of this service makes it superior to regular class room instruction alone. It takes care of individual differences so that a student proceeds as rapidly as he wishes. The fast are not held back with the slow.

It is difficult enough for small schools to obtain teachers at all. Fortunately, many of them are able, through supervised correspondence courses, to continue to make available the high school subjects for which they do not have qualified instructors.

Supervised correspondence study has long been used as a means of making available to high school pupils subjects that could not readily be offered by the regular class method. Today this technique demonstrates its usefulness by successfully meeting the demands or limitations of students in the small high school, students in the large high school, and others outside of school who desire to continue their education and advance in their present work or enter some new field.

Supervised correspondence study is a means of introducing the elements of flexibility and enrichment into the program of almost any high school at any time.

In California, the State Board of Education and the State Superintendent of Public Instruction have been delegated the responsibility of prescribing rules and regulations: (1) which would make reliable correspondence courses available to the schools and to the students and (2) which would provide adequate guidance and supervision for this type of instruction both to the youth desiring certain courses, not otherwise available in the small high school, and to youth who wish training beyond or in addition to courses available in their local school.

The University of California has adequate facilities to provide instruction in a total of 86 courses, approved for acceptance by the university in fulfillment of entrance requirements. Through proper arrangement prior to enrollment with the high schools or colleges and universities, it is now possible in California to receive credit for the work satisfactorily completed by correspondence study.

Of all the states contacted, Massachusetts appears to be the leader and outstanding component of extension work. In addition to the many hundreds of courses offered through class instruction in the Greater Boston area, the work of the extension service reaches into every village and small settlement in the state.

One important phase of the Massachusetts Department of Education is the high school equivalency program designed for veterans of World War II, which has received more than

seven thousand applications of young men and women who are eager to earn a high school certificate. The office of radio offers educational programs in cooperation with many of the broadcasting stations of the Commonwealth and by this means readies more than 200,000 children and adults. Adult civic education is another part of its work, and through its efforts many thousands of foreign born are being trained in good citizenship. As mentioned previously, education by correspondence is a most vital phase of this department. The soundness of this method of education is well known. A large amount of determination is required for a class student to complete his work, but it takes more determination on the part of the correspondence student, who must work alone without the enthusiasm which comes from association with his fellows. Among the rolls of the correspondence students will be found the most earnest people in the state.

The Commonwealth gives correspondence instruction in approximately two hundred different subjects in a program of offerings which is comprehensive enough to meet virtually any individual pupil's interest or need: Among the many courses offered are those in the fields of English, language, mathematics, social studies, science, household arts, and industrial courses.

In an effort to increase its service to its students, the Division is constantly on the look out for opportunities

to improve its program. Courses are constantly being reviewed and new ones added.

One of the most common methods employed by small schools for the expansion of their curriculum offerings is the alternation of subjects. By alternating courses, the program of studies of a given school may be extended from one-fifth to one-third of the number of offerings that could be taught otherwise by the regular staff. The extent of the use of alternation depends upon the particular school. It is easily administered but requires some knowledge of its application. As a rule, courses which are organically and vocationally alike should be alternated. This method is most commonly applied to third and fourth year courses but can also be used with other courses. The major criterion is whether the earlier courses are prerequisites to later courses. Most of the subject fields readily lend themselves to the alternating procedure. It is common practice to alternate such courses as third and fourth year English, chemistry and physics, or biology or any two of these sciences, general science and general mathematics, and second and third year agriculture and home economics.

In most states, the consolidation of schools appears to be the gravest educational need. The upkeep of the very small schools is costly to the state and to the local units and the students in these small schools are deprived of the

better educational opportunities they would get in larger schools equipped to give training in vocational and agricultural studies. In North Carolina, a total of 600 of the high schools employ four or fewer teachers, 114 of them employ two teachers. In some of the one-teacher and two-teacher high schools the teachers have to give more instructions in studies for which they haven't prepared than in studies in which they majored in college.

The small high school staff must train for college that proportion of farm youth, however small, which in every community looks toward higher education. The responsibility of keeping the door to the college open to all aspiring youth rests so heavily upon the average rural high school that many provide nothing but college preparatory courses. The very difficult problem in the small high school of providing vocational orientation and specialized training to that large and growing segment of rural youth who must seek a livelihood in non-farming industries and in urban communities has shown rapid development by most of the smaller high schools of the United States.

The movement towards consolidation of rural schools and transportation of the children to a central school has already attained considerable headway in many regions of the country. Starting in Massachusetts in 1869, consolidation is now a part of the rural school system in thirty-eight states. During the past twenty-five years, consolidation has

been gaining headway and is now going on at least five times as fast as the average for the preceding fifty years. The most rapid development appearing in the mid-western states. The broad and general sweep of the movement, together with the fact that it is practically unheard of for schools that have once tried consolidation to go back to the old system, seems to indicate that the rural or small school education of the not distant future will, except in a few regions, be carried on in consolidated school.

A device for the expansion of the instructional program of a school which is gradually being recognized is the practice of granting school credit for work done out-of-school under the supervision of the school. This is not a general practice as many State Departments of Education have established certain limitations as to its use. However, this method is used by many small schools in attempting to overcome their limitations. It may be used in many subjects such as agriculture, home economics, science, and industry. The school provides the theory, and by cooperation with the home, business, and industry, the pupils can get the practice. In such subjects the time of the teachers devoted to instruction can be lessened and thereby devoted to other activities.

Throughout the country, many high schools and colleges operate summer schools providing a variety of subjects open to any and all interested students. Advantages of educational

opportunities not provided in a small school may well be cared for during this vacation period. Not only do summer schools help to overcome the limitations of a small school but they also provide an opportunity for students to make up work failed in order to return to school in the fall with others promoted to the next higher grade. Although practically all high school subjects are offered in schools of this type, restrictions are generally placed on the number of subjects one may pursue. Most schools have set a maximum of two courses; a few allow three.

The Y. M. C. A. Summer High School conducted by the Worcester Junior College, Worcester, Massachusetts, is a typical school. With the exception of commercial subjects, it offers practically every other high school subject. The teaching staff is made up of teachers selected from the faculties of the Worcester High Schools. Since these teachers are familiar with the methods used in the Worcester public high schools, as well as the content of the various courses, they are able to teach with particular effectiveness. In general, classes are kept small, thus permitting the teacher to give more attention to the individual student. Trial promotions for five weeks the following year are granted providing the student receives a grade of B in the specific subject for which credit is desired.

The last method, and one that is highly recognized, in increasing educational opportunities of small high schools

is the utilization of circuit teachers. This method has proven very satisfactory in the mid-western and southern states. It is the method small schools have of employing part-time teachers of subjects which the school alone could not afford. Two or more schools located sufficiently close to each other cooperate and share in the services of this type teacher.

With a knowledge of the instructional materials and methods available to supplement a small high school curriculum, no student in any rural or small school should feel he is at a handicap in so far as his educational opportunities are concerned. He may be confronted with a small number of teachers and a limited program of studies but his prospects and potentialities for the future are as bright and as great as that of any other pupil in the country.

Suggestions for further study:

1. There is a need for a survey of the remaining thirty-five State Departments of Education regarding the methods used by each to overcome the limitations or shortcomings of their respective rural high schools.
2. A study should be made of the college requirements as compared to the programs of study of the small schools in the different sections of the country.

CHAPTER VI

CORRESPONDENCE COURSES

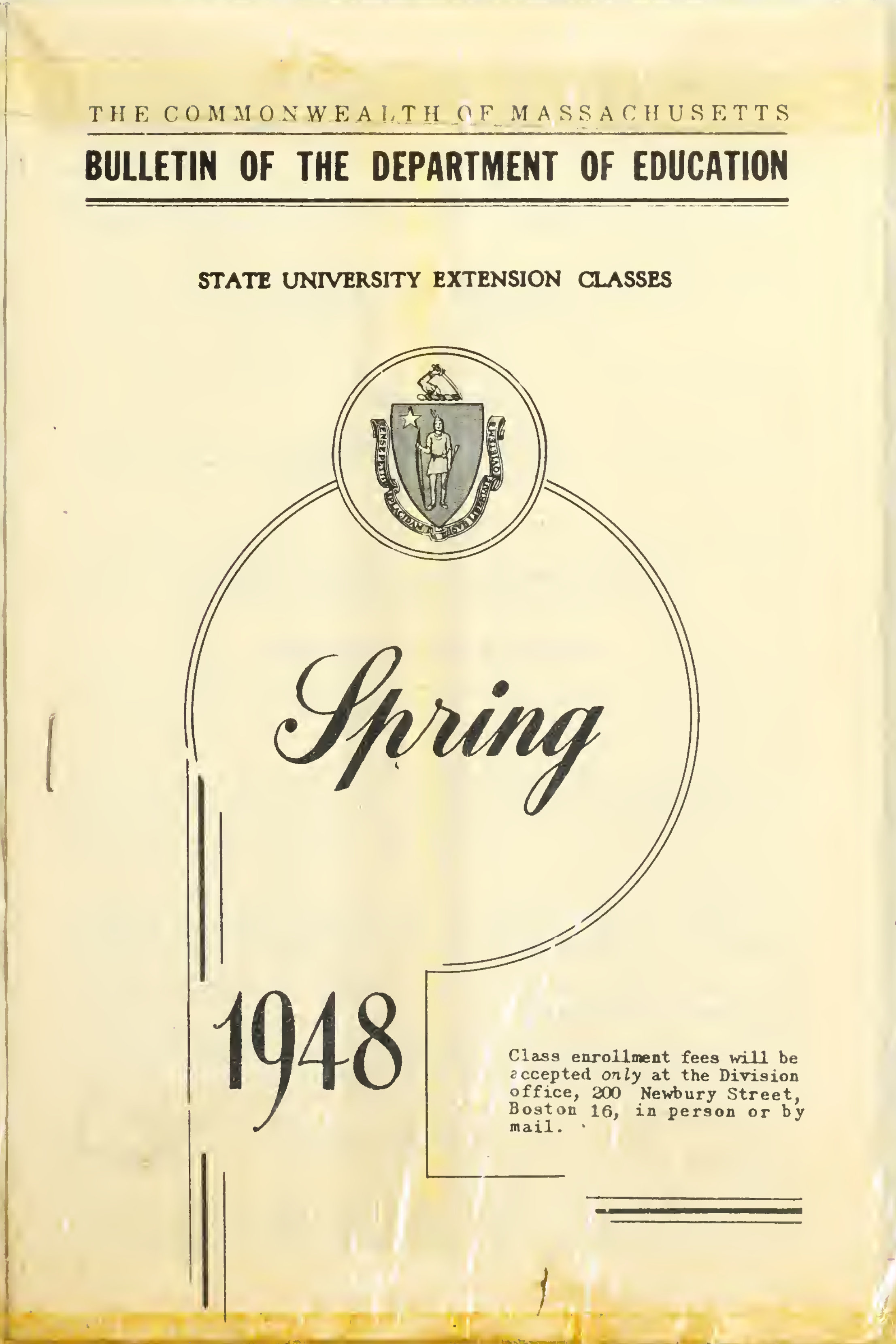
CHAPTER VI

CORRESPONDENCE COURSES

In addition to text book material, research information, unit assignments, and laboratory work; the rural and small school student, regardless of his location, may explore further into the field of science or any other field by means of night schools, summer schools, and correspondence courses. Whereas certain methods and materials mentioned in this study may not be at one's disposal, correspondence courses are available to all. The Massachusetts State Department of Education, Boston, Massachusetts; various State universities and colleges; the National Home Study Council and the United States Armed Forces Institute; and the International Correspondence School, Scranton, Pennsylvania, offer courses of this type which may be studied at home in conjunction with courses offered by the local high school. As an aid to students, a set of pamphlets and catalogues including a list of courses offered by the above mentioned correspondence schools follows. Sample lessons furnished by the Massachusetts Department of Education and the International Correspondence schools are also included.

BROCHURE I

STATE UNIVERSITY EXTENSION CLASSES



THE COMMONWEALTH OF MASSACHUSETTS

BULLETIN OF THE DEPARTMENT OF EDUCATION

STATE UNIVERSITY EXTENSION CLASSES

Spring

1948

Class enrollment fees will be accepted *only* at the Division office, 200 Newbury Street, Boston 16, in person or by mail.

BULLETIN OF THE DEPARTMENT OF EDUCATION

VOL. XXXIII, NO. 11 MARCH 15, 1948 WHOLE NO. 951

Published weekly by the Division of University Extension, State Education Building, Newbury and Exeter Streets, Boston. Entered as second class matter November 19. 1915, at the post office at Boston, Mass., under the act of Congress of August 24, 1912. Acceptance for mailing at special rate of postage provided for in section 1103, Act of October 3, 1917, authorized on August 15, 1918.

DEPARTMENT OF EDUCATION

JOHN J. DESMOND, JR., Commissioner

Division of University Extension

E. EVERETT CLARK, *Director*

STATE UNIVERSITY EXTENSION CLASSES IN BOSTON AND VICINITY

REGISTRATION.- *Enrollments will be accepted only at the State Education Building, Newbury and Exeter Streets, Boston 16, in person or by mail. The enrollment charge,* which is stated in the announcement of each course, *must accompany the application for enrollment.*

Remittances by register check, money order, or personal check made payable to *Commonwealth of Massachusetts* are preferred.

For information on *Free Instruction for Veterans,* see the next page of this bulletin.

The first meeting of each class is open to the public. Admittance thereafter will be by membership ticket *only.*

The Division reserves the right to withdraw a course at any time. *Any class without a minimum enrollment of 20 at the second meeting will be suspended.*

Applications for refunds of enrollment charges or for transfers to other courses *must be made in writing.* On applications for refunds or transfers, at least one dollar and a proportionate part of the charge, depending on the cost of the course and the number of meetings the class has met and irrespective of the number of meetings the student has attended, will be retained. In transferring from one course to another, the student must also pay any difference in the charge for a more expensive course than that in which he was originally enrolled. No refunds will be given on applications received after the *third* meeting of a class and no transfers will be allowed after the *fourth* meeting. Students should advise the Division promptly of their intention to withdraw from a course, and in making application for a refund or transfer, they must submit their membership ticket.

HOLIDAY RECESSES AND POSTPONEMENTS.- University Extension classes will not meet on legal holidays.

Emergency postponements, such as those caused by heavy snowstorms, will be announced by special radio news flashes at 2 and 6 p.m., over the major stations.

CERTIFICATES are granted to students whose average is 70 per cent or over and whose attendance is reasonably good. For some courses an examination is required. Exceptions to this general procedure are stated in the course announcement.

COLLEGE CREDIT.- An asterisk (*) following the name of a course announced in this bulletin indicates that the course is of college grade. Such courses carry the usual college credit of one semester hour for each fifteen lecture hours spent in class. Any student who wants to make certain that he will receive college credit for a university extension course of college grade must make inquiry at the institution where he intends to apply for credit. An *auditor* is not entitled to paper correction and will not receive credit or a certificate.

FREE INSTRUCTION FOR VETERANS.- Chapter 439 of the Acts of 1946 provides that any resident of Massachusetts, a veteran of World War II who served at least 60 days, and has a discharge other than dishonorable may enroll without charge for instruction in any class or correspondence course offered by the Division of University Extension for a period of 4 years. The cost of textbooks and laboratory fees, if any, will be borne by the veteran. All that a veteran needs to do is to bring his honorable discharge (or a photostatic copy) to 200 Newbury Street or to the first meeting of the class. Veterans whose discharges are recorded with the Division need not present them the second time.

Any *disabled* veteran of World War I or World War II who is a resident of Massachusetts at the present time may take University Extension class or correspondence courses without charge. There is no time limitation on this opportunity. The cost of textbooks and laboratory fees, if any, will be borne by the veteran. *To take advantage of this opportunity, the disabled veteran should* *obtain a certificate of disability from the United States Veterans Administration, which will be filed in this office.*

A schedule of classes by days of the week follows. Numbers in last column indicate pages on which courses are listed.

MONDAYS

Art of Flower Arrangement	549 Boylston Street	April 5	5
Commercial Art**	Sever Hall	April 5	5
Conference Leadership	M. I. T.	April 5	8
Decoration of the American Home	Boston Teachers College	March 22	9
Fundamentals of Public Speaking**	Sever Hall	April 5	8
German I**	Sever Hall	April 5	7
Home Gardens	Sever Hall	April 5	10
Mental Hygiene**	Sever Hall	April 5	9
Photographic Coloring	M. I. T.	April 5	6
Real Estate Law**	Harvard Hall	April 5	6
Sketching and Painting	Boston Teachers College	April 5	5
Social Psychology**	Sever Hall	April 5	9
Weight Normalizing	Pierce Building	April 5	9

TUESDAYS

Chemistry of Modern Cosmetics	M. I. T.	April 20	6
Diesel Engines**	M. I. T.	April 6	10
Economic Geography**	Sever Hall	April 6	8
Elementary Gregg Shorthand**	Harvard Hall	April 6	6
Elementary Solfeggio**	823 Boylston Street	April 6	7
Employer - Employee Relations**	M. I. T.	April 6	8
Fundamentals of Radio**	M. I. T.	April 6	10
Interior Home Decoration	264 Boylston Street	April 13	9
Preparation for Electricians' Examination**	M. I. T.	April 6	10
Quality Control in Industry	M. I. T.	April 6	8
Voice Training for Singing	725 Boylston Street	April 6	7

WEDNESDAYS

Advanced Fiction Technique**	Sever Hall	April 7	7
Better Speech	Sever Hall	April 14	8
Factory Planning	M. I. T.	April 7	8
Hostess Training**	71 Newbury Street	March 31	6
Problems of the Postwar Settlements in Europe and Asia**	Sever Hall	April 7	9
Some Masters of French Thought	Boston Public Library	April 7	7

Steam and Gas Turbine Theory and Practice**	M. I. T.	April 7	10
Supervisory Training	M. I. T.	April 7	8
Terminal Science	Girls Latin School	April 7	11
Writing for Women	Boston Public Library	April 7	8

THURSDAYS

Better Automobile Driving	M. I. T.	April 8	10
Elementary Typewriting**	128 Commonwealth Avenue	April 1	6
Everyday English**	Sever Hall	April 22	7
French I**	Sever Hall	April 8	7
Office Procedure for Doctors' Secretaries**	Sever Hall	April 15	6
Principles and Problems of Guidance**	Sever Hall	April 1	9
Radiant Heating	M. I. T.	April 8	10
Salesmanship**	Harvard Hall	April 8	6
Short Story Writing**	Sever Hall	April 1	7
Slide Rule and Its Use	M. I. T.	April 1	10
Weather for the Layman	M. I. T.	April 8	11

FRIDAYS

Blueprint Reading for Building Trades	M. I. T.	April 16	10
Out-of-Door Photography for the Amateur	M. I. T.	April 9	6
Personality Improvement	Boston Teachers College	April 2	9

**Class meets twice a week

The complete addresses of the places of meeting will be found at the end of this bulletin.

ART AND PHOTOGRAPHY

ART OF FLOWER ARRANGEMENT.- D. WM. QUINT, Florist. Mondays, 7:30 to 9 p.m., beginning April 5, 1948, at 549 Boylston Street, Eight lectures. Charge: $5.

COMMERCIAL ART.- ANNE P. GUYTON, Commercial Artist. Mondays and Wednesdays, 7:45 to 9:15 p.m., beginning Monday, April 5, 1948, at Sever Hall. Fifteen lessons. Charge: $9. Materials extra. *Enrollment is limited to thirty-five students.*

SKETCHING AND PAINTING.- AMERICO M. DIFRANZA, formerly Instructor, Museum of Fine Arts, Boston. Mondays, 7:30 to 9 p.m., beginning April 5, 1948, at Boston Teachers College. Eight lessons. Charge: $5. Materials extra. *Enrollment is limited to thirty-five students.*

OUT-OF-DOOR PHOTOGRAPHY FOR THE AMATEUR.- STILLMAN POWERS, Manager, Powers Studio, Boston. Fridays, 7:30 to 9 p.m., beginning April 9, 1948, at Massachusetts Institute of Technology. Four lectures on Friday evenings and four field trips on Saturday afternoons. Charge: $6. Materials extra.

PHOTOGRAPHIC COLORING.- MR. POWERS. Mondays, 7:30 to 9 p.m., beginning April 5, 1948, at Massachusetts Institute of Technology. Eight lessons. Charge: $5. Materials extra.

BUSINESS AND SECRETARIAL

CHEMISTRY OF MODERN COSMETICS.- NATHAN WHITE, Manufacturing Chemist. Tuesdays, 7:30 to 9:30 p.m., beginning April 20, 1948, at Massachusetts Institute of Technology. Twelve lessons. Charge: $10.

HOSTESS TRAINING.- HONOR M. O'CONNOR, Supervisor, Howard Johnson Restaurants. Wednesdays and Fridays, 8 to 10 p.m., beginning Wednesday, March 31, 1948, at Massachusetts Restaurant Association, 71 Newbury Street, Boston. Eight lessons. Charge: $7.

REAL ESTATE LAW*.- WILLIAM J. CASHMAN, Attorney-at-Law. Mondays and Wednesdays, 6 to 7:45 p.m., beginning Monday, April 5, 1948, at Harvard Hall. Fifteen lessons; two semester hours. Charge for credit students, $14 (nonresidents of Massachusetts, $16); charge for auditors, $10. Textbook extra.

SALESMANSHIP*.- WENDELL H. BERRY, formerly Instructor in Salesmanship, Northeastern University (Springfield Division). Tuesdays and Thursdays, 6 to 7:45 p.m., beginning Thursday, April 8, 1948, at Harvard Hall. Fifteen lessons; two semester hours. Charge for credit students, $14 (nonresidents of Massachusetts, $16); charge for auditors, $10. Textbook extra.

ELEMENTARY GREGG SHORTHAND.- FREDERICK L. CARNEY, Boston School Department. Tuesdays and Thursdays, 7:45 to 9:15 p.m., beginning Tuesday, April 6, 1948, at Harvard Hall. Fifteen lessons. Charge: $10.

ELEMENTARY TYPEWRITING.- JOHN K. KEELON, Boston School Department. Mondays and Thursdays, 5 to 6:30 p.m., beginning Thursday, April 1, 1948, at 128 Commonwealth Avenue. Sixteen lessons. Charge: $13. *Enrollment is limited to thirty-five students.*

OFFICE PROCEDURE FOR DOCTORS' SECRETARIES.- FRANCES J. BARRIE, Experienced Medical Secretary. Tuesdays and Thursdays, 7 to 8:30 p.m., beginning Thursday, April 15, 1948, at Sever Hall. Twelve lessons. Charge: $8. Textbook extra.

MUSIC AND LANGUAGES

ELEMENTARY SOLFEGGIO*.- LEONA MACGRAW, Graduate, New England Conservatory of Music. Tuesdays and Thursdays, 7:30 to 9:15 p.m., beginning Tuesday, April 6, 1948, at 823 Boylston Street, Boston. Fifteen lessons; two semester hours. Charge for credit students, $14 (nonresidents of Massachusetts, $16); charge for auditors, $10. Textbook extra.

VOICE TRAINING FOR SINGING.- KEITH CROSBY BROWN, Head, Music Department, Mount Ida Incorporated. Tuesdays, 6:30 to 8 p.m., beginning April 6, 1948, at 725 Boylston Street. Eight lessons. Charge: $5. Textbook extra.

FRENCH I (Beginners)*.- ROLAND N. FONTAINE, Boston School Department. Tuesdays and Thursdays, 7:45 to 9:30 p.m., beginning Thursday, April 8, 1948, at Sever Hall. Fifteen lessons; two semester hours. Charge for credit students, $14 (nonresidents of Massachusetts, $16); charge for auditors, $10. Textbook extra.

GERMAN I (Beginners)*.- BERTHA REED COFFMAN, Associate Professor of German, Emeritus, Simmons College. Mondays and Wednesdays, 6 to 7:45 p.m., beginning Monday, April 5, 1948, at Sever Hall. Fifteen lessons; two semester hours. Charge for credit students, $14 (nonresidents of Massachusetts, $16); charge for auditors, $10. Textbooks extra.

SOME MASTERS OF FRENCH THOUGHT.- ANDRE MORIZE, Professor of French Literature, Harvard University. Wednesdays, 5 to 6 p.m., beginning April 7, 1948, at Lecture Hall, Boston Public Library. Eight lectures. Charge: $5. (A noncertificate course.)

WRITING AND SPEECH

EVERYDAY ENGLISH.- GERALD F. COUGHLIN, Boston School Department. Mondays and Thursdays, 6 to 7:30 p.m., beginning Thursday, April 22, 1948, at Sever Hall. Eight lessons. Charge: $4. Textbook extra.

ADVANCED FICTION TECHNIQUE*.- TRENTWELL MASON WHITE, Editor and Author. Wednesdays and Fridays, 6 to 7:45 p.m., beginning Wednesday; April 7, 1948, at Sever Hall. Fifteen lessons; two semester hours. Charge for credit students, $18 (nonresidents of Massachusetts, $20); charge for auditors, $10. Textbook extra.

SHORT STORY WRITING*.- CHARLES CHADWICK, Author; Instructor, Harvard Commission on Extension Courses. Mondays and Thursdays, 7:45 to 9:30 p.m., beginning Thursday, April 1, 1948, at Sever Hall. Fifteen lessons; two semester hours. Charge for credit students, $18 (nonresidents of Massachusetts, $20); charge for auditors, $10. Textbook extra.

WRITING FOR WOMEN.- AGNES CARR, Feature Editor, The Boston *Herald-Traveler*. Wednesdays, 3 to 4:30 p.m., beginning April 7, 1948, at Lecture Hall, Boston Public Library. Eight lessons. Charge: $5.

BETTER SPEECH (for Social, Business, and Professional Success).- HELENE BOLL, Author and Lecturer. Wednesdays, 7:45 to 9:15 p.m., beginning April 14, 1948, at Sever Hall. Eight lessons. Charge: $5.

FUNDAMENTALS OF PUBLIC SPEAKING*.- JOSEPH G. BRIN, Professor, Boston University School of Public Relations. Mondays and Wednesdays, 7:30 to 9:15 p.m., beginning Monday, April 5, 1948, at Sever Hall. Fifteen lessons; two semester hours. Charge for credit students, $14 (nonresidents of Massachusetts, $16); charge for auditors, $10. Textbook extra.

COURSES FOR EXECUTIVES

CONFERENCE LEADERSHIP.- SAMUEL R. CARLISLE, Consultant in Industrial Relations. Mondays, 7:30 to 9 p.m., beginning April 5, 1948, at Massachusetts Institute of Technology. Eight lessons. Charge: $8. Textbook extra.

EMPLOYER-EMPLOYEE RELATIONS*.- HARRY M. DOYLE, Professor of Social Studies, Boston College. Tuesdays and Fridays, 7:30 to 9:15 p.m., beginning Tuesday, April 6, 1948, at Massachusetts Institute of Technology. Fifteen lectures; two semester hours. Charge for credit students, $14 (nonresidents of Massachusettts $16); charge for auditors, $10. Textbook extra.

FACTORY PLANNING.- RICHARD J. WOLF, Industrial Engineer, Stone & Webster, Inc. Wednesdays, 7:30 to 9 p.m., beginning April 7, 1948, at Massachusetts Institute of Technology. Eight lessons. Charge: $5. Textbook extra.

QUALITY CONTROL IN INDUSTRY.- LOUIS ROSENBLUM, Industrial Engineer, Polaroid Corporation. Tuesdays, 7:30 to 9 p.m., beginning April 6, 1948, at Massachusetts Institute of Technology. Eight lessons. Charge: $5. Textbook extra.

SUPERVISORY TRAINING.- DAMON B. HATCH, Foreman, Gillette Safety Razor Company. Wednesdays, 7:30 to 9 p.m., beginning April 7, 1948, at Massachusetts Institute of Technology. Eight lessons. Charge: $5. Textbook extra.

COURSES FOR TEACHERS

ECONOMIC GEOGRAPHY*.- GEORGE Q. HILL, formerly Assistant, Social Science Department, Boston University, College of Business

Administration. Tuesdays and Fridays, 7:45 to 9:30 p.m., beginning Tuesday, April 6, at Sever Hall. Fifteen lessons; two semester hours. Charge for credit students, $14 (nonresidents of Massachusetts, $16); charge for auditors, $10. Textbook extra.

MENTAL HYGIENE*#.- HARRY M. DOYLE, Professor of Social Studies, Boston College. Mondays and Thursdays, 7:45 to 9:30 p.m., beginning Monday, April 5, 1948, at Sever Hall. Fifteen lessons; two semester hours. Charge for credit students, $14 (nonresidents of Massachusetts, $16); charge for auditors, $10. Textbook extra.

PRINCIPLES AND PROBLEMS OF GUIDANCE*.- LOUISE C. KEYES, Boston School Department. Tuesdays and Thursdays, 7:45 to 9:30 p.m., beginning Thursday, April 1, 1948, at Sever Hall. Fifteen lectures; two semester hours. Charge: $14 (nonresidents of Massachusetts, $16). Textbook extra.

PROBLEMS OF THE POSTWAR SETTLEMENTS IN EUROPE AND ASIA*.- DANIEL O'LEARY, Boston School Department. Wednesdays and Fridays, 7:45 to 9:30 p.m., beginning Wednesday, April 7, 1948, at Sever Hall. Fifteen lessons; two semester hours. Charge for credit students, $14 (nonresidents of Massachusetts, $16); charge for auditors, $10. Textbook extra.

SOCIAL PSYCHOLOGY*.- LOWELL S. TROWBRIDGE, Instructor in Psychology, Boston University, College of Business Administration. Mondays and Wednesdays, 7:15 to 9 p.m., beginning Monday, April 5, 1948, at Sever Hall. Fifteen lectures; two semester hours. Charge for credit students, $14 (nonresidents of Massachusetts, $16); charge for auditors, $10. Textbook extra.

COURSES FOR WOMEN

DECORATION OF THE AMERICAN HOME, Part II.- AGNES F. FENNELLY, Staff, University Extension. Mondays, 7:45 to 9:15 p.m., beginning March 22, 1948, at Boston Teachers College. Eight lessons. Charge: $4.

INTERIOR HOME DECORATION.- LILLIAN A. PHILLIPS, formerly Instructor in Design and Crafts, Massachusetts School of Art. Tuesdays, 9:30 to 11 a.m., beginning April 13, 1948, at 264 Boylston Street. Six lectures. Charge: $3.

PERSONALITY IMPROVEMENT.- MAUD PRESTON GREGSON, formerly associated with The House of Worth and Harrod's Ltd., London, and Couturier Salons, Paris. Fridays, 7:30 to 9 p.m., beginning April 2, 1948, at Boston Teachers College. Eight lessons. Charge: $5.

WEIGHT NORMALIZING.- KATHARINE D. O'GORMAN, Graduate, Wellesley College, Department of Physical Education. Mondays, 6 to 7:30 p.m., beginning April 5, 1948, at Pierce Building (Room 218). Eight lessons. Charge: $4.

# Also offered for graduate credit.

BETTER AUTOMOBILE DRIVING.- BERNARD GARBER, Director, Driver Education and Training School. Thursdays, 7:30 to 9 p.m., beginning April 8, 1948, at Massachusetts Institute of Technology. Eight lessons. Charge: $5.

BLUEPRINT READING FOR BUILDING TRADES.- JOSEPH F. KENNEY, Architect; Instructor in Blueprint Drafting, Boston School Department. Fridays, 7:30 to 9 p.m., beginning April 16, 1948, at Massachusetts Institute of Technology. Eight lessons. Charge: $5. Textbook extra.

DIESEL ENGINES.- RALPH D. CHAMBERLAIN, formerly Instructor in Mechanical Engineering, Massachusetts Diesel Institute. Tuesdays and Thursdays, 7:30 to 9 p.m., beginning Tuesday, April 6, 1948, at Massachusetts Institute of Technology. Sixteen lessons. Charge: $10. Textbook extra.

FUNDAMENTALS OF RADIO.- FRANCIS C. W. LAZENBY, Radio Engineer. Tuesdays and Thursdays, 7:30 to 9 p.m., beginning Tuesday, April 6, 1948, at Massachusetts Institute of Technology. Sixteen lessons. Charge: $10. Textbook extra.

HOME GARDENS.- GEORGE A. SWEETSER, Landscape Designer and Horticulturist. Mondays, 7:30 to 9 p.m., beginning April 5, 1948, at Sever Hall. Eight lessons. Charge: $6. Textbook extra.

PREPARATION FOR ELECTRICIANS' EXAMINATION.- JAMES L. BURKE, Instructor in Electricity, Medford Vocational School. Tuesdays and Thursdays, 7:30 to 9 p.m., beginning Tuesday, April 6, 1948, at Massachusetts Institute of Technology. Sixteen lessons. Charge: $10. Textbook extra.

RADIANT HEATING.- DONALD W. NORDBECK, Heating Consultant. Thursdays, 7:30 to 9 p.m., beginning April 8, 1948, at Massachusetts Institute of Technology. Eight lessons. Charge: $5.

SLIDE RULE AND ITS USE.- ELWOOD R. JOHNSTON, JR., Assistant in Engineering, Massachusetts Institute of Technology. Thursdays, 7:30 to 9 p.m., beginning April 1, 1948, at Massachusetts Institute of Technology. Eight lessons. Charge: $5.

STEAM AND GAS TURBINE THEORY AND PRACTICE*.- EDWARD C. PERRY, JR., formerly, Turbine Engineering Department, General Electric Company. Wednesdays and Fridays, 7:30 to 9:15 p.m., beginning Wednesday, April 7, 1948, at Massachusetts Institute of Technology. Fifteen lessons; two semester hours. Charge for credit students, $14 (nonresidents of Massachusetts, $16); charge for auditors, $10. Textbook extra.

TERMINAL SCIENCE.– RALPH DELANO, Boston School Department. Wednesdays, 7:30 to 9 p.m., beginning April 7, 1948, at Girls Latin School. Eight lessons. Charge: $5.

WEATHER FOR THE LAYMAN.– ESTHER M. TURNBULL, formerly Meteorologist, United States Army. Thursdays, 7:30 to 9 p.m., beginning April 8, 1948, at Massachusetts Institute of Technology. Eight lessons. Charge: $5. Textbook extra.

PLACES OF MEETING

Boston Public Library, Boylston Street entrance, Copley Square, Boston.

Boston Teachers College, Huntington and Longwood Avenues, Boston.

Girls Latin School, Huntington near Longwood Avenue, Boston.

Harvard Hall, Harvard University, Harvard Square, Cambridge.

Massachusetts Institute of Technology, 77 Massachusetts Avenue, Cambridge.

Pierce Building, Copley Square, Boston.

Sever Hall, Harvard University, Harvard Square, Cambridge.

264 Boylston Street, near Arlington Street, Boston (Women's Educational and Industrial Union).

549 Boylston Street, near Dartmouth Street, Boston.

725 Boylston Street, near Exeter Street, Boston (Studio I, second floor).

823 Boylston Street, near Massachusetts Station, Boston (A. M. Hume Piano Company).

128 Commonwealth Avenue, near Dartmouth Street, Boston (Stratford School).

71 Newbury Street, near Berkeley Street, Boston (Massachusetts Restaurant Association).

For information, telephone KEnmore 6-4670
"University Extension."

Z-3358 Ticket No. ....

DEPARTMENT OF EDUCATION

DIVISION OF UNIVERSITY EXTENSION

200 Newbury Street, Boston 16

FOR CLASS REGISTRATION ONLY

REGISTER CHECKS, MONEY ORDERS, OR PERSONAL CHECKS for enrollment should be used whenever possible. Make checks payable to *Commonwealth of Massachusetts.*

Name...
(print name in full)

Mailing Address..
(street and number)

City or Town..............................State ....
(zone number)

Telephone No..............................Date ....

Course...

At..Fee Paid..............
(City or Town)

The Commonwealth of Massachusetts

DEPARTMENT OF EDUCATION

Blank for Registration in Courses offered by the Division of University Extension

The following application is to be filled out completely in the applicant's own handwriting. Please avoid abbreviations and complete the blank in detail.

Date of application ....

Name (print in full) ....

Mailing address (street and number) ....

Town or City .... **State** ....

Home address ....

Age .... **Telephone No.** ....

By whom employed? ....

In what country were you born? ....

Occupation ....

Experience in business, industry or teaching ....

....

....

Education (in full) ....

....

What foreign languages have you studied? ....

Name courses you have taken with this Division, if any ....

....

Names of courses desired ....

....

Reason for selecting these courses ....

How many hours per week can you give to home study? ....

Remittance: $ .... **by**
- Currency (in registered letter)
- Certified Check
- Money Order

Please make remittance payable to "Commonwealth of Massachusetts."

(Note: If you know of persons likely to be interested in extension courses, please write their names and addresses on the back of this application blank.)

Registration is not complete unless the registration charges, paid in full, accompany this blank, which is to be sent to E. Everett Clark, Director, State Education Building, 200 Newbury Street, Boston 16, Mass.

15m (a)-3-46-18077

BROCHURE II

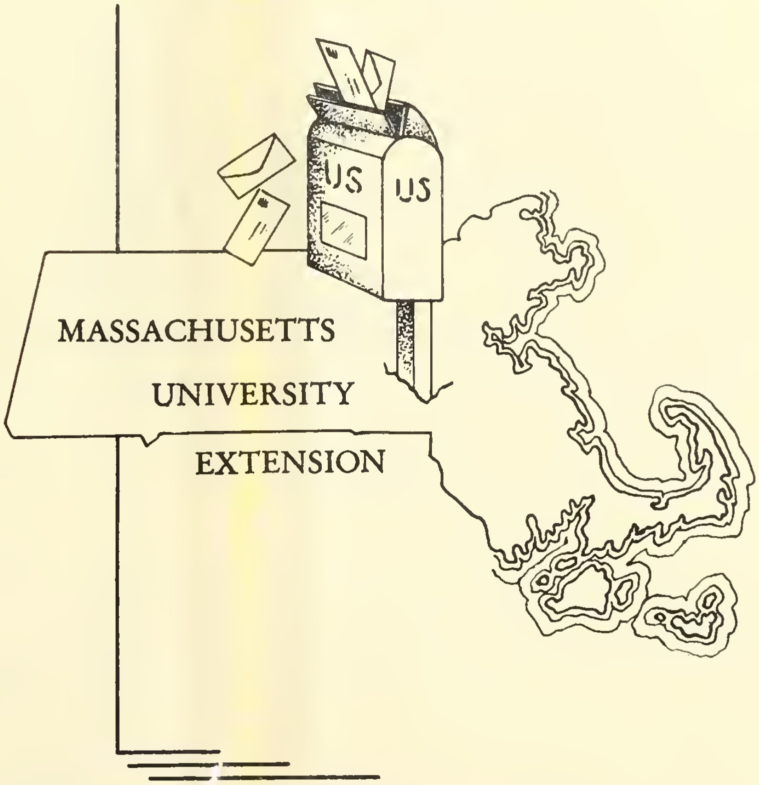
STATE SUPPORTED HOME STUDY COURSES

THE COMMONWEALTH OF MASSACHUSETTS

BULLETIN OF THE DEPARTMENT OF EDUCATION

STATE-SUPPORTED

HOME STUDY COURSES



GENERAL ACADEMIC SUBJECTS

BUSINESS SUBJECTS

BULLETIN OF THE DEPARTMENT OF EDUCATION

Vol. XXXII, No. 13 March 31, 1947 Whole No. 901

DEPARTMENT OF EDUCATION

JOHN J. DESMOND, JR., Commissioner

Division of University Extension

E. EVERETT CLARK, *Director*

Ellen Fitzpatrick, *Supervisor in Education*
Helen B. Garrity, *Supervisor in Education*
Mary L. Guyton, *Supervisor of Adult Civic Education*
Otto Kiessling, *Supervisor in Education*
John P. McGrail, *Supervisor in Education*
Leo F. A. Murphy, *Assistant Supervisor in Education*
Ursula K. Toomey, *Assistant Supervisor in Education*

Z-3248

Published weekly by the Division of University Extension, State Education Building, Newbury and Exeter Streets, Boston.. Entered as second class matter November 19, 1915, at the post office at Boston, Mass., under the act of Congress of August 24, 1912. Acceptance for mailing at special rate of postage provided for in section 1103, Act of October 3, 1917, authorized on August 15, 1918.

CORRESPONDENCE INSTRUCTION

Instruction by correspondence, when properly organized, has been proved to be of great value to students who cannot attend classes under personal direction. Its organization requires that the course of instruction shall be prepared and administered with regard to the practical difficulties encountered by a student not in personal contact with his teacher, and that students who enroll in particular courses shall have given evidence of their qualifications to pursue such courses with success. Obviously these qualifications include the preliminary training or experience required to pursue the course successfully, as well as the habits of attention and persistence that are peculiarly necessary in this field of instruction. The correspondence courses announced in this bulletin are in almost all cases based on lesson pamphlets and books that have been extensively tested as a means of correspondence instruction.

Enrollment and Method of Conducting Courses. - The first step to be taken by a student wishing to enroll in a correspondence course is to fill out and send to the Division an application blank accompanied by the enrollment charge. Students may enroll for one part at a time in those courses which are divided into parts, and, unless advised to the contrary by the Division, should always enroll in Part I first. Enrolling otherwise may require an adjustment in the enrollment charge. One of these application blanks will be found at the back of this bulletin. If his statements satisfy the Division as to his ability to pursue successfully the course named, he is enrolled. Otherwise, further information will be requested, and, if necessary, specific examinations must be passed, before enrollment can be secured.

After enrollment, the student will receive the lesson pamphlets which give instructions for study and for the preparation of lesson reports. Each lesson report when completed is to be sent to the instructor, by whom it will be corrected and returned to the student with written comment. A student's rate of progress depends entirely on the amount of time he is able to devote to study. He is advised to ask questions in writing as to any problems arising in the work which he is doing.

Correspondence courses may be started at any time. - They may be taken by either men or women. The Division reserves the right to withdraw a course at any time or change the enrollment charge.

Expenses of Courses. - A student is required to pay in advance the amount indicated in the description of the course in which he is enrolling. He must also prepay the postage or express charges on material sent to his instructor for correction. Unless otherwise stated, and if enrollment is made in accordance with the directions given in the paragraph above, the enrollment charge covers the cost of all lesson materials, textbooks, and stationery needed in the course. Generally speaking, the text material is furnished with that part of the course which has the higher enrollment charge.

Payments should be made by postal or express money order, check or bank draft *payable to the Commonwealth of Massachusetts*, or currency sent in a registered letter. Do not send stamps. *All communications should be sent to E. Everett Clark, Director, University Extension, State Education Building, Newbury and Exeter Streets, Boston 16, Massachusetts.*

Veterans of World War II who reside in Massachusetts may take University Extension courses without charge for instruction. All that a veteran needs to do is to bring or send his honorable discharge (preferably a photostatic copy) and proof of residence in Massachusetts to 200 Newbury Street, Boston 16. Veterans whose discharges are recorded with the Division need not present them the second time. Veterans are entitled to four years of such free instruction under the law. The expense of any textbooks or laboratory supplies which a course may require will be borne by the student. The cost will be furnished upon request.

ENGLISH

Ninth Grade English - College Preparatory, Parts I and II. - Ten assignments in each part; one high school unit. Charges: Part I, $10; Part II, $6 (to non-residents, Part I, $14; Part II, $10).

Ninth Grade English - General, Parts I and II. - Ten assignments in each part; one high school unit. Charges: Part I, $10; Part II, $6 (to non-residents, Part I, $14; Part II, $10).

Ninth Grade English - Practical, Parts I and II. - Ten assignments in each part; one high school unit. Charges: Part I, $9.50; Part II,$6 (to non-residents, Part I, $13.50; Part II, $10).

Tenth Grade English - College Preparatory, Parts I and II. - Ten assignments in each part; one high school unit. Charges: Part I, $10; Part II, $6 (to non-residents, Part I, $14; Part II, $10).

Tenth Grade English - General, Parts I and II. - Ten assignments in each part; one high school unit. Charges: Part I, $10; Part II, $6 (to non-residents, Part I, $14; Part II, $10).

Tenth Grade English - Practical, Parts I and II. - Ten assignments in each part; one high school unit. Charges: Part I, $9.75; Part II, $6 (to non-residents, Part I, $13.75; Part II, $10).

Eleventh Grade English - College Preparatory, Parts I and II. - Ten assignments in each part; one high school unit. This course consists of a study of American Literature and emphasizes the principles of effective writing. Charges: Part I, $10.50; Part II, $6 (to non-residents, Part I, $14.50; Part II, $10).

Eleventh Grade English - General, Parts I and II. - Ten assignments in each part; one high school unit. This course consists of a study of American Literature and emphasizes the principles of effective writing. Charges: Part I, $10.50; Part II, $6 (to non-residents, Part I, $14.50; Part II, $10).

Eleventh Grade English - Practical, Parts I and II. - Ten assignments in each part; one high school unit. Charges: Part I, $10; Part II, $6 (to non-residents, Part I, $14; Part II, $10).

Twelfth Grade English - College Preparatory, Parts I and II. - Ten assignments in each part; one high school unit. This course consists of a study of English Literature and a review of grammar. Charges: Part I, $12; Part II, $6 (to non-residents, Part I, $16; Part II,$10).

Twelfth Grade English - General, Parts I and II. - Ten assignments in each part; one high school unit. This course consists of a study of English Literature and a review of grammar. Charges: Part I, $12; Part II, $6 (to non-residents, Part I, $16; Part II, $10).

Twelfth Grade English - Commercial, Parts I and II. - Ten assignments in each part; one high school unit. This course consists of a study of English Literature, a review of grammar, and a study of effective business correspondence. Charges: Part I, $13.75; Part II, $6 (to non-residents, Part I, $17.75; Part II, $10).

Twelfth Grade English - Practical, Parts I and II. - Ten assignments in each part; one high school unit. Charges: Part I, $10; Part II, $6 (to non-residents, Part I, $14; Part II, $10).

Plain English, Parts I and II. - Ten assignments in each part. A review of eighth grade English. Charges: $4 for each part; (to non-residents, $6 for each part).

Elementary English and Rhetoric, Parts I and II. - Ten assignments in each part. A review of high school grammar and rhetoric. Charges: $5 for each part (to non-residents, $8 for each part).

Vocabulary Building, Parts I, II, and III. - Eight assignments in each part. Charges: Part I, $6; Parts II and III, $5 each (to non-residents, Part I, $9; Parts II and III, $8 each).

Punctuation and Paragraphing. - Eight assignments. Charges: $4 (to non-residents, $6).

First-Year College English, Parts I and II. - Twelve assignments in each part; three semester hours. Charges: Part I, $11.50; Part II, $7.50 (to non-residents, Part I, $16; Part II, $12).

Journalism, Parts I and II. - Eight assignments in each part; two semester hours. Charges: Part I, $9; Part II, $6 (to non-residents, Part I, $12; Part II, $9).

English for Business, Parts I and II. - Eight assignments in each part. Charges: Part I, $7; Part II, $5 (to non-residents, Part I, $10; Part II, $8).

Commercial Correspondence, Parts I and II. - Ten assignments in each part; two and one-half semester hours. Charges: Part I, $7.50; Part II, $6 (to non-residents, Part I, $11.50; Part II, $10).

MUSIC

Appreciation of Music. - Ten assignments. Charges: $5 (to non-residents, $8).

Appreciation of Orchestral Music - Symphonies. - Eight assignments. Charges: $5 (to non-residents, $8).

Harmony, Parts I, II, III, IV, V, VI, and VII. - Eight assignments in each part; seven semester hours. Charges: Part I, $8; Parts II, III, IV, V, VI, and VII, $5 each (to non-residents, Part I, $11; Parts II, III, IV, V, VI, and VII, $8 each).

Counterpoint, Parts I and II. - Eight assignments in each part; two semester hours. Charges: $6 for each part (to non-residents, $9 for each part).

HOME-MAKING

Exterior Home Decoration - Landscape Gardening. - Six assignments. Charges: $4 (to non-residents, $6).

Foods and Nutrition, Parts I and II. - Eight assignments in each part; one high school unit. Charges: Part I, $8; Part II, $5 (to non-residents, Part I, $11; Part II, $8).

Dietetics. - Fourteen assignments; one and three-quarters semester hours. Charges: $12 (to non-residents, $17.25).

ART

Amateur Sketching. - A course for beginners. Eight assignments. Charges: $7 (to non-residents, $10). These charges include a kit consisting of a set of water color pencils, brushes, sketching pencils, and drawing paper. Students who do not need this kit should deduct $2.

Sketching and Painting. - This course follows Amateur Sketching. Eight assignments. Charges: $8 (to non-residents, $11). These charges include a kit consisting of a set of water color pencils, brushes, sketching pencils, and drawing paper. Students who do not need this kit should deduct $2.

Commercial Art, Parts I and II. - This course follows Sketching and Painting. Eight assignments in each part. Charges: Part I, $14.50; Part II, $6 (to non-residents, Part I, $17.50; Part II, $9). The necessary supplies are included in the charges for Part I.

Show Card Writing, Part I. - Ten assignments. Charges: $10 (to non-residents, $14).

Show Card Writing, Part II. - Ten assignments. Charges: $10 (to non-residents, $14).

Commercial Lettering. - Six assignments. Charges: $6.50 (to non-residents, $8.50).
Note: The charges for the three courses above include all the necessary supplies.

HISTORY and GOVERNMENT

Elementary United States History and Government, Parts I and II. - Ten assignments in each part; one high school unit. Charges: Part I, $9.25; Part II, $6 (to non-residents, Part I, $13.25; Part II, $10).

English History, Parts I and II. - Eight assignments in each part; one high school unit. Charges: Part I, $7.50; Part II, $5 (to non-residents, Part I, $10.50; Part II, $8).

Modern European History, Parts I and II. - Eight assignments in each part; one high school unit. Charges: Part I, $7.25; Part II, $5 (to non-residents, Part I, $10.25; Part II, $8).

Ancient History, Parts I and II. - Eight assignments in each part; one high school unit. Charges: Part I, $8.25; Part II, $5 (to non-residents, Part I, $11.25; Part II, $8.00).

United States History, Parts I, II, III, and IV. - Twelve assignments in each part; six semester hours. Charges: Part I, $11; Part II, $7.50; Part III, $11; Part IV, $7.50 (to non-residents, Part I, $15.50; Part II, $12; Part III, $15.50; Part IV, $12). Parts II, III, and IV will be available after July 1, 1947.

American Government, Parts I and II. - Eight assignments in each part; two semester hours. Charges: Part I, $9; Part II, $5 (to non-residents, Part I, $12; Part II, $8).

Problems of Democracy. - Ten assignments; one-half high school unit. Charges: $8 (to non-residents, $12).

EDUCATION

Educational Psychology, Parts I, II, and III. - Eight assignments in each part; three semester hours. Charges: Part I, $11.50; Parts II and III, $5 each (to non-residents, Part I, $14.50; Parts II and III, $8).

History of Education, Parts I and II. - Eight assignments in each part; two semester hours. Charges: Part I, $9; Part II, $5 (to non-residents, Part I, $12; Part II, $8).

Philosophy of Education, Parts I and II. - Eight assignments in each part; two semester hours. Charges: Part I, $8; Part II, $5 (to non-residents, Part I, $11; Part II, $8).

Vocational Guidance, Parts I and II. - Eight assignments in each part; two semester hours. Charges: $6 for each part, (to non-residents, $9 for each part).

Methods of Teaching Mathematics. - Eight assignments; one semester hour. Charges: $8 (to non-residents, $11).

Elementary Spanish, Parts I and II. - Ten assignments in each part; two high school units or two and one-half semester hours. Charges: Part I, $8.50; Part II, $6 (to non-residents, Part I, $12.50; Part II $10).

Commercial Spanish, Parts I and II. - Ten assignments in each part; two and one-half semester hours. Charges: Part I, $11; Part II, $6 (to non-residents, Part I, $15; Part II, $10).

Portuguese. - Fourteen assignments; one high school unit. Charges: $10 (to non-residents, $15).

French, Course I, Parts I and II. - Eight assignments in each part; one-half high school unit or two semester hours. Charges: Part I, $8; Part II, $5 (to non-residents, Part I, $11; Part II, $8).

French, Course II. - Sixteen assignments; one-half high school unit or two semester hours. Charges: $13 (to non-residents, $19). Students who have completed Course I and have the texts used in that course should deduct $3 from the charge for Course II.

French, Course III. - Sixteen assignments; one-half high school unit or two semester hours. Charges: $13.50 (to non-residents, $19.50). Students who have completed Course II and have the grammar used in that course should deduct $2 from the charge for Course III.

Elementary Latin, Parts I, II, III, and IV. - Eight assignments in each part; one high school unit. Charges: Part I, $6.50; Parts II, III, and IV, $5 each (to non-residents, Part I, $9.50; Parts II, III, and IV, $8 each).

Elementary Latin A, Parts I and II. - Ten assignments in each part. This is a supplementary reading course. It may also be used as a refresher for first year's work. Charges: Part I, $7.50; Part II, $6 (to non-residents, Part I, $11.50; Part II, $10).

Caesar, Parts I, II, III, and IV. - Ten assignments in each part; one high school unit. Charges: Part I, $8; Parts II, III, and IV, $6 each (to non-residents, Part I, $12; Parts II, III, and IV, $10 each

Cicero, Parts I, II, III, and IV. - Eight assignments in each part; one high school unit. Charges: Part I, $8; Parts II, III, and IV, $5 each (to non-residents, Part I, $11; Parts II, III, IV, $8 each).

Vergil, Parts I, II, III, and IV. - Eight assignments in each part; one high school unit. Charges: Part I, $7; Parts II, III, and IV, $5 each (to non-residents, Part I, $10; Parts II, III, and IV, $8 each).

Elementary Italian, Course I, Parts I and II. - Eight assignments in each part; one high school unit or two semester hours. Charges: Part I, $8; Part II, $5 (to non-residents, Part I, $11; Part II, $8).

Elementary Italian, Course II. - Sixteen assignments; one high school unit or two semester hours. Charges: $14 (to non-residents, $20). Students who have completed Course I and have the texts used in that course should deduct $3 from the charge for Course II.

Elementary German, Course I, Parts I and II. - Eight assignments in each part; one-half high school unit or two semester hours. Charges: Part I, $6.50; Part II, $5 (to non-residents, Part I, $9.50; Part II, $8).

Elementary German, Course II. - Sixteen assignments; one-half high school unit or two semester hours. Charges: $11.50 (to non-residents, $17.50). Students who have completed Course I and have the text used in that course should deduct $1.50 from the charge for Course II.

German, Course III. - Sixteen assignments; one-half high school unit or two semester hours. Charges: $14.50; (to non-residents, $20.50).

ECONOMICS

Business Economics, Parts I and II. - Eight assignments in each part; one high school unit. Charges: Part I, $7; Part II, $5 (to non-residents, Part I, $10; Part II, $8).

Elements of Economics, Parts I and II. - Eight assignments in each part; two semester hours. Charges: Part I, $7.75; Part II, $5 (to non-residents, Part I, $10.75; Part II, $8).

PSYCHOLOGY

Psychology in Everyday Life, Parts I and II. - Eight assignments in each part; two semester hours. Charges: Part I, $8.25; Part II, $5(to non-residents, Part I, $11.25; Part II, $8).

SCIENCE

Botany, Parts I and II. - Ten assignments in each part; one high school unit. Charges: Part I, $9; Part II, $6 (to non-residents, Part I, $13; Part II, $10).

Elementary Biology, Parts I and II. - Eight assignments in each part; one high school unit. Charges: Part I, $7; Part II, $5 (to non-residents, Part I, $10; Part II, $8).

Elementary Chemistry, Parts I and II. - Ten assignments in each part; one high school unit. Charges: Part I, $8; Part II, $6 (to non-residents, Part I, $12; Part II, $10).

General Science, Parts I and II. - Ten assignments in each part; one high school unit. Charges: Part I, $8; Part II, $6 (to non-residents, Part I, $12; Part II, $10).

Physics, Parts I, II, and III. - Twelve assignments in each part; one high school unit. Charges: Part I, $11.00; Parts II and III, $7.50 each (to non-residents, Part I, $15.50; Parts II and III, $12 each).

Astronomy. - Ten assignments. Charges: $7 (to non-residents, $11).

MATHEMATICS

Elementary Algebra, Parts I and II. - This course takes the subject up to quadratics. Eight assignments in each part; one high school unit. Charges: Part I, $7; Part II, $5 (to non-residents, Part I, $10; Part II, $8).

Intermediate Algebra, Parts I and II. - Eight assignments in each part; one high school unit. Charges: Part I, $7; Part II, $5 (to non-residents, Part I, $10; Part II, $8). Students who have completed **Elementary Algebra, Parts I and II**, and who have the text used in that course, should deduct $2 from the charges for Part I.

Plane Geometry, Parts I and II. - Ten assignments in each part; one high school unit. Charges: Part I, $7.50; Part II, $6 (to non-residents, Part I, $11.50; Part II, $10).

Solid Geometry. - Ten assignments; one-half high school unit. Charges: $7.50 (to non-residents, $11.50).

Mathematics Review, Parts I, II, III, and IV. - Eight assignments in each part; one high school unit. Charges: Part I, $8; Parts II, III, and IV, $5 each (to non-residents, Part I, $11; Parts II, III, and IV, $8 each).

Trigonometry, Parts I and II. - Ten assignments in each part; one high school unit or two and one-half semester hours. Charges: Part I, $10; Part II, $8 (to non-residents, Part I, $14; Part II, $12).

Calculus, Parts I and II. - Ten assignments in each part; two and one-half semester hours. Charges: Part I, $11.75; Part II, $8 (to non-residents, Part I, $15.75; Part II, $12).

BOOKKEEPING and ACCOUNTING

Bookkeeping. Parts I. II, and III. - Eight assignments in each part; one high school unit. Charges: Part I, $6.50; Parts II and III, $5 each (to non-residents, Part I, $9.50; Parts II and III, $8 each).

Modern Accounting, First Course, Parts I, II, III, and IV. - Eight assignments in each part; four semester hours. This is the first of a series of three courses designed to give intensive training in all important features of modern accounting and is intended for those who plan to make accounting their profession. Charges: Part I, $11, Part II, $6.75; Parts III and IV, $5 each (to non-residents, Part I, $14, Part II, $9.75; Parts III and IV, $8 each).

Modern Accounting, Intermediate, Parts I, II, III, and IV. - Eight assignments in each part; four semester hours. Charges: Part I, $10; Parts II, III, and IV, $5 each (to non-residents; Part I, $13; Parts II, III, IV, $8 each).

Modern Accounting, Advanced, Parts I, II, III, and IV. - Eight assignments in each part; four semester hours. Charges: Part I, $10; Parts II, III, and IV, $5 each (to non-residents, Part I, $13; Parts II, III, and IV, $8 each).

Fundamentals of Auditing, Parts I and II. - Eight assignments in each part; two semester hours. Charges: Part I, $10.75; Part II, $6 (to non-residents, Part I, $13.75; Part II, $9).

Industrial Accounting, Parts I and II. - Eight assignments in each part; three semester hours. This course is intended for those who wish to gain an understanding of the processes and executive uses of industrial accounting. Charges: Part I, $9.25; Parts II and III, $5 each (to non-residents, Part I, $12.25; Parts II and III, $8 each).

LAW

Business Law, Parts I and II. - Eight assignments in each part; two semester hours. Charges: Part I, $8.50; Part II, $5 (to non-residents, Part I, $11.50; Part II, $8).

Real Estate Law, Parts I and II. - Eight assignments in each part; two semester hours. Charges: $6 for each part (to non-residents, $9 for each part).

SALESMANSHIP and ADVERTISING

Successful Salesmanship, Parts I and II. - Eight assignments in each part; Charges: Part I, $6.50; Part II, $5 (to non-residents, Part I, $9.50; Part II, $8).

Retail Selling. - Ten assignments. Charges: $7 (to non-residents, $11).

Fundamentals of Advertising, Parts I and II. - Eight assignments in each part; two semester hours. Charges: Part I, $9; Part II, $5 (to non-residents, Part I, $12; Part II, $8). *Part II available after July 1, 1947.*

A correspondence course may be started at any time.

MANAGEMENT

Personnel Management, Parts I and II. - Eight assignments in each part; two semester hours. Charges: Part I, $9; Part II, $5 (to non-residents, Part I, $12; Part II, $8).

Office Management, Parts I and II. - Eight assignments in each part; two semester hours. Charges: Part I, $7.50; Part II, $5 (to non-residents, Part I, $10.50; Part II, $8).

Industrial Organization and Management, Parts I and II. - Eight assignments in each part; two semester hours. Charges: Part I, $9; Part II, $5 (to non-residents, Part I, $12; Part II, $8).

TIME STUDY - INDUSTRIAL SAFETY - FOREMANSHIP

Time Study, Parts I and II. - Eight assignments in each part; two semester hours. Charges: Part I, $13; Part II, $8 (to non-residents, Part I, $17; Part II, $12).

Industrial Safety, Parts I and II. - Eight assignments in each part; two semester hours. Charges: Part I, $8; Part II, $5 (to non-residents, Part I, $11; Part II, $8).

Foreman Training. - Ten assignments. Charges: $8.50 (to non-residents $12.50).

Effective Foremanship, Parts I and II. - *Open to those who have had foremanship experience or who have completed the course in* Foreman Training. Eight assignments in each part. Charges: Part I, $10.50; Part II, $8 (to non-residents, Part I, $14.50; Part II, $12).

CLERICAL and STENOGRAPHIC PREPARATORY COURSES

Everyday Arithmetic. - Ten assignments. Charges: $4 (to non-residents, $6).

Business Arithmetic, Parts I and II. - Ten assignments in each part. Charges: Part I, $6.50; Part II, $5 (to non-residents, Part I, $9.50; Part II, $8).

Business Mathematics, Parts I and II. - Eight assignments in each part. Charges: Part I, $6; Part II, $6 (to non-residents, Part I, $9; Part II, $9).

Typewriting, Parts I, II, and III. - Eight assignments in each part; one high school unit. Charges: Part I, $6.50; Parts II and III, $5 each (to non-residents, Part I, $9.50; Parts II and III, $8 each).

Gregg Shorthand, Parts I, II, and III. - Twelve assignments in each part; one high school unit. Charges: $8 for each part (to non-residents, $12.50 for each part).

Thomas Natural Shorthand. - Ten assignments; one-half high school unit. Charges: $10 (non-residents, $14). *Available after July 1, 1947.*

Office Procedure for Medical Secretaries. - Ten assignments. Charges: $8 (to non-residents, $12).

ANSWERS TO QUESTIONS FREQUENTLY ASKED BY PERSONS INTERESTED IN CORRESPONDENCE COURSES

Correspondence courses may be started at any time.

Students may enroll in one part at a time (second paragraph, page 3).

The primary prerequisite of a college level course is a high school education or its equivalent. It should be understood, however, that enrollment in college level courses is not limited to high school graduates, but they may be taken by any adult who by experience and training other than formal schooling is qualified to derive profit from such courses.

Regardless of the kind of course a student chooses, he should consider his own abilities and obtain advice wherever possible. He should select a course in terms of his educational background, his practical work experience, his desires, his interests, and his willingness to apply himself. He should not, for example, choose a course in engineering unless he has had a good background in mathematics. He should not choose a course in industrial management unless he has had practical experience in an industrial plant or has had special training in this field. By taking into consideration the educational level of the course and his educational background, he should have no difficulty in making the proper choice.

Courses on the college level have a credit value of one semester hour for each eight assignments (e.g., a sixteen assignment course has a value of two semester hours). Arrangements for receiving degree credit for such courses must be made by the student with the college from which he expects to receive his degree. The Division does not grant degrees, but it grants a diploma for the completion of sixty semester hours in an approved program of college level courses in any one of the following fields: Academic Arts, Music, Business Administration, Mechanical Engineering, Electrical Engineering, Civil Engineering.

Courses on the high school level have a credit value of one unit (or five points), except a few short courses of eight to twelve assignments which have a credit value of one-half unit. These high school courses are accepted for credit toward the State High School Equivalency Certificate in Massachusetts. Arrangements for receiving credit for them toward a local high school diploma, toward an equivalency certificate in another state, or for entrance to a college, have to be made by the student with the proper local, state, or college official.

Courses taken for either college or high school credit must be completed with supervised examinations.

Circulars giving more details about courses listed in this pamphlet will be sent upon request.

The Commonwealth of Massachusetts

REGISTRATION IN CORRESPONDENCE COURSES

An applicant for instruction in a University Extension course is required to fill out a registration blank, giving such information as will enable the Director to determine his fitness to pursue the course selected. This application should be filled out completely in the applicant's own handwriting, preferably in ink. Registration is not complete unless the registration charges, paid in full, accompany the application for enrollment, which should be sent to E. Everett Clark, Director, University Extension, State Education Building, Newbury and Exeter Streets, Boston 16, Mass.

Send money order or check. Do not risk currency except in a registered letter.

Once enrolled the student receives by mail the lesson pamphlets. When he has finished the work of the first assignment, the student mails his papers to the State Education Building, where a staff instructor examines and grades them and records on them his corrections, criticisms, and comments.

Courses consist of a varying number of assignments or lessons, usually from eight to twenty. Each assignment represents the work that should be done by a student of average ability in from eight to twelve hours of attentive study. Each lesson represents, therefore, approximately a week's work.

Enrollment for correspondence instruction may be made at any time.

- -

Name *(PRINT* in full)..

Mailing Address ....

(Street and number)

....

(Town or city) (State)

Age...............Telephone No. ....Occupation..............................

From what schools or colleges, if any, have you *graduated?*

....

....

Name courses you have taken in this Division, if any {completed.................................

uncompleted..............................

NAMES OF COURSES DESIRED..

....

....

I am sending $..........by {Money order

Check

Currency (in registered letter)

Date of application..

SPECIAL ANNOUNCEMENT

by the

DIVISION OF UNIVERSITY EXTENSION

RELATING TO

CORRESPONDENCE COURSES

in

HIGH SCHOOL SUBJECTS

THIS BULLETIN SHOULD BE OF PARTICULAR INTEREST TO VETERANS WHO HAVE ATTENDED THE REGIONAL VETERANS EDUCATION CENTERS AND TO OTHERS.

SPECIAL ANNOUNCEMENT BY THE DIVISION OF UNIVERSITY EXTENSION RELATING TO CORRESPONDENCE COURSES IN HIGH SCHOOL SUBJECTS

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A detailed review of the utilization of University Extension correspondence courses in the Regional Veterans Education Centers is not here necessary. It is enough to state that the successful completion of these courses has materially helped veterans to obtain local high school diplomas and State High School Equivalency Certificates, and to meet other needs and special interests.

It is now proposed to supplement the activities of these Centers by providing for direct enrollment with the Division of University Extension in correspondence courses by:

1. The veteran who finds himself obliged to leave the Center but who wishes to complete the course or courses he has been studying.

2. The veteran who wishes to complete the course or courses which he could not finish because of necessary closing out of the Center.

3. The veteran who lives in a community where there is no readily accessible Center.

The following procedures should be followed:

1. If the veteran desires to complete a correspondence course or courses undertaken in a Center, which have been interrupted for any reason, an official statement should be sent to the Division noting for any given course for each person the number of assignments satisfactorily completed, grades, lesson and other materials at hand, and recommendations or comments. This statement should be accompanied by a completed enrollment blank provided by the Division and should carry a special notation such as, "Formerly a student in the ____________ Regional Veterans Education Center." If an enrollee under this plan has not already met the requirements noted in #4 below, it will be necessary for him to do so before his enrollment can be cleared.

2. New enrollments can be made by mail or in person at the Division office. (If enrollment blanks or information are desired please communicate with the Division of University Extension.)

3. The local school system should endeavor to offer at least a limited amount of teacher supervision of correspondence study similar to that given in the Regional Veterans Education Centers. Such service is essential and invaluable.

4. Veterans of World War II who reside in Massachusetts may take University Extension courses without charge for instruction. All that a veteran needs to do is to bring or send his honorable discharge (preferably a photostatic copy) and proof of residence in Massachusetts to 200 Newbury Street, Boston 16. Veterans whose discharges are recorded with the Division need not present them the second time. Veterans are entitled to four years of such free instruction under the law. The expense of any textbooks or laboratory supplies which a course may require will be borne by the student. The cost will be furnished upon request.

5. All correspondence should be addressed to E. Everett Clark, Director, Division of University Extension, 200 Newbury Street, Boston 16.

Special Note:

These correspondence courses and some 150 others are available to non-veterans at low cost.

* * * * * * * * * * * *

TITLES OF COURSES
ENGLISH

*NINTH GRADE ENGLISH, Parts I and II.- Ten assignments in each part; one high school unit.

*TENTH GRADE ENGLISH, Parts I and II.- Ten assignments in each part; one high school unit.

*ELEVENTH GRADE ENGLISH, Parts I and II.- Ten assignments in each part; one high school unit. This course consists of a study of American Literature and emphasizes the principles of effective writing.

*TWELFTH GRADE ENGLISH, Parts I and II.- Ten assignments in each part; one high school unit. This course consists of a study of English Literature and a review of grammar.

* Available on college preparatory (except Ninth Grade), general, commercial (Twelfth Grade only), and practical levels.

LANGUAGES

ELEMENTARY SPANISH, Parts I and II.- Ten assignments in each part; two high school units.

COMMERCIAL SPANISH, Parts I and II.- Ten assignments in each part; one high school unit.

PORTUGUESE.- Fourteen assignments; one high school unit.

FRENCH, Course I, Parts I and II.- Eight assignments in each part ; one-half high school unit.

FRENCH, Course II.- Sixteen assignments; one-half high school unit.

FRENCH, Course III.- Sixteen assignments; one-half high school unit.

FRENCH, Course IV.- Sixteen assignments; one-half high school unit.

ELEMENTARY LATIN, Parts I, II, III, and IV.- Eight assignments in each part; one high school unit.

CAESAR, Parts I, II, III, and IV.- Ten assignments in each part; one high school unit.

CICERO, Parts I, II, III, and IV.- Eight assignments in each part; one high school unit.

VERGIL, Parts I, II, III, and IV.- Eight assignments in each part; one high school unit.

ELEMENTARY ITALIAN, Course I, Parts I and II.- Eight assignments in each part; one high school unit.

ELEMENTARY ITALIAN, Course II.- Sixteen assignments; one high school unit.

ELEMENTARY GERMAN, Course I, Parts I and II.- Eight assignments in each part; one-half high school unit.

ELEMENTARY GERMAN, Course II.- Sixteen assignments; one-half high school unit.

GERMAN, Course III.- Sixteen assignments; one-half high school unit.

MATHEMATICS

ELEMENTARY ALGEBRA, Parts I and II.- Course takes subject up to quadratics. Eight assignments in each part; one high school unit.

INTERMEDIATE ALGEBRA, Parts I and II.- Starts with quadratics and prepares the student for college algebra. Eight assignments in each part; one high school unit.

PLANE GEOMETRY, Parts I and II.- Ten assignments in each part; one high school unit.

SOLID GEOMETRY.- Ten assignments; one-half high school unit.

MATHEMATICS REVIEW, Parts I, II, III, and IV.- Similar to course usually offered in the last year of high school which provides rapid review of first year algebra and plane geometry before taking up more advanced phases of both subjects. Eight assignments in each part; one high school unit.

TRIGONOMETRY, Parts I and II.- Ten assignments in each part; one high school unit.

SOCIAL STUDIES

ELEMENTARY UNITED STATES HISTORY AND GOVERNMENT, Parts I and II.- Ten assignments in each part; one high school unit.

ENGLISH HISTORY, Parts I and II.- Eight assignments in each part; one high school unit.

MODERN EUROPEAN HISTORY, Parts I and II.- Eight assignments in each part; one high school unit.

ANCIENT HISTORY, Parts I and II.- Eight assignments in each part; one high school unit.

PROBLEMS OF DEMOCRACY.- Ten assignments; one-half high school unit.

BUSINESS ECONOMICS, Parts I and II.- Eight assignments in each part; one high school unit.

SCIENCE

BOTANY, Parts I and II.- Ten assignments in each part; one high school unit.

ELEMENTARY BIOLOGY, Parts I and II.- Eight assignments in each part; one high school unit.

ELEMENTARY CHEMISTRY, Parts I and II.- Ten assignments in each part; one high school unit.

GENERAL SCIENCE, Parts I and II.- Ten assignments in each part; one high school unit.

PHYSICS, Parts I, II, and III.- Twelve assignments in each part; one high school unit.

ASTRONOMY.- Ten assignments; one-half high school unit.

COMMERCIAL SUBJECTS

BUSINESS ARITHMETIC, Parts I and II.- Ten assignments in each part; one high school unit.

BUSINESS MATHEMATICS, Parts I and II.- Eight assignments in each part; one high school unit.

BOOKKEEPING, Parts I, II, and III.- Eight assignments in each part; one high school unit.

BUSINESS LAW, Parts I and II.- Eight assignments in each part; one high school unit.

GREGG SHORTHAND, Parts I, II, and III.- Twelve assignments in each part; one high school unit.

THOMAS NATURAL SHORTHAND.- Ten assignments; one-half high school unit.

TYPEWRITING, Parts I, II, and III.- Eight assignments in each part; one high school unit.

SUCCESSFUL SALESMANSHIP, Parts I and II.- Eight assignments in each part; one high school unit.

HOUSEHOLD ARTS

FOODS AND NUTRITION, Parts I and II.- Eight assignments in each part; one high school unit.

INDUSTRIAL

BLUEPRINT READING FOR THE MACHINE TRADES, Parts I and II.- Eight assignments in each part; one high school unit.

MECHANICAL DRAWING, Parts I and II.- Ten assignments in each part; one high school unit.

MECHANICAL DRAWING, Parts III and IV.- Ten assignments in each part; one high school unit.

BLUEPRINT READING FOR THE BUILDING TRADES, Parts I and II.- Eight assignments in each part; one high school unit.

INDUSTRIAL ELECTRICITY AND WIRING, Parts I and II.- Eight assignments in each part; one high school unit.

ELEMENTS OF RADIO, Parts I, II, III, and IV.- Fourteen assignments in each part; two high school units.

PRE-FLIGHT AERONAUTICS, Parts I, II, III, and IV.- Eight assignments in each part; one high school unit.

PRE-FLIGHT METEOROLOGY.- Eight assignments; one-half high school unit.

PRE-FLIGHT NAVIGATION.- Eight assignments; one-half high school unit.

PRACTICAL APPLIED MATHEMATICS.- Twelve assignments; one-half high school unit.

ADVANCED SHOP MATHEMATICS, Parts I and II.- Ten assignments in each part; one high school unit.

PRACTICAL MECHANICS, Parts I and II.- Ten assignments in each part; one high school unit.

Division of University Extension Massachusetts Dept,. of Education
ELEMENTARY CHEMISTRY, Part I. Assignment I.

Aim of the Course

Chemistry Related to Everyday Things.- For a long time chemistry was studied almost entirely as a science with practically little bearing on the everyday things of life. This study served only those who intended to specialize in some of the advanced branches of science.

Up to a comparatively recent time, the causes and effects of common phenomena have been taken more or less for granted. For instance, most persons have not been interested in the chemical principles that explain why soda water is sparkling, why soap removes grease and dirt from most fabrics, or why yeast causes bread to rise. In these modern days of science, however, our education is not complete unless we have some knowledge of the chemistry of everyday things.

The aim of this course in Elementary Chemistry is to show how closely chemistry is related to the common activities of life. It seeks to serve individuals in every walk of life: in industry, in the home, or in the school. The course may also serve as a basis for future work as a chemist.

Elementary Chemistry, Part I, consists of ten assignment and treats of fundamental chemistry.

Elementary Chemistry, Part II, also consisting of ten assignments, is a continuation of Part I, but it is more advanced in its content.

Method of the Course

General Directions.- The textbook used in this course is Chemistry by Hogg, Alley, and Bickel. The publisher is D. Van Nostrand Company, New York. (The textbook is hereafter referred to as

Chemistry.) All page references given in the assignments are references to this textbook.

Each assignment consists of two parts: the study material and the lesson report. The lesson report usually has two parts, A and B. All A questions must be answered. The B questions are optional and need to be answered only by students wishing training in the mathematical phases of chemistry.

First read very carefully the assigned portion of the textbook. Then proceed to examine in detail the additional material given in the assignment.

The various topics taken up in each assignment are underlined. Under each topic you will find a reference to the pages in your textbook on which this particular subject is treated. Review these selections very carefully and also study the material given in the assignment to explain or supplement the points taken up in the textbook.

When you feel that you understand thoroughly the study material of the assignment, write out, to the best of your ability, the answers to the questions given in the Lesson Report. Do not look at the textbook or refer to any material in the assignment when you are answering these questions.

Send your Lesson Report to the address given at the end of each assignment. An experienced instructor will carefully examine your work and will make suggestions and corrections. You are undertaking this course to gain a knowledge of chemistry; your instructor is always at your service to give you any needed help to gain that knowledge. Therefore, do not hesitate to ask questions on any difficulties that may arise.

Youwill be allowed as much time as you need for the mastery of each assignment, but do not let your work lag and grow stale. Success in correspondence instruction depends largely on promptness and regularity in submitting the lesson reports.

Required Reading: Chemistry: Chapter 1, pages 1-11
Chapter 2, pages 12-19.

Note.- It is, of course, impossible to furnish laboratory practice by correspondence. It is also true that most chemical experiments require special and costly apparatus and materials. Yet we believe that some of the experiments outlined in each chapter of the textbook are simple and may be performed with the facilities available in any home. You will find that trying such experiments, though they are not required, will add greatly to your enjoyment and understanding of the subject.

What is Chemistry?- Chemistry is that branch of science which deals with the composition of things about us and the changes which they undergo. It enters so intimately into our everyday life that many of the familiar changes with which we are acquainted are not recognized as having any relation to the subject of chemistry. The food that we eat, the water that we drink, the air that we breathe, and many processes in our common industries all depend upon nature's substances and their changes.

Constitution of Matter.- Let us examine a piece of charcoal. If we can imagine that our eyes are strong magnifiers, we see that the lump of charcoal is not just one piece but is made up of millions of minute particles. If it were possible for us to look still more closely, we should find that all these particles are of the same size and shape, and that they are continually in motion, hitting against

one another and then rebounding. These particles, which have all the properties of the larger piece, are called molecules, a word meaning little bodies.

If we were to examine one of these molecules, we should find that it is not just one body but consists of two smaller bodies, both of the same nature. These smaller bodies are called atoms. A molecule is composed of two or more atoms. A substance, such ar charcoal, made up of atoms of the same kind (carbon atoms in the case of charcoal), is called an element. Two or more elements held together by the force of chemical attraction form a compound. For further information on this subject, read pages 13-14 in your textbook.

When structural units of matter are put together to form new substances, the process is called synthesis.

States of Matter.- Learn a few examples of different states of matter (pages 12-13).

Size and Motion of Molecules.- Read pages 14-16 to get some idea about how small molecules are. Movements of atoms and molecules are explained on pages 16-18.

Structure of the Atom.- Study the diagrams of the hydrogen and oxygen atoms on page 16. Learn that electrons are negatively charged particles of matter, and that protons are positively charged and are located in the central region of an atom.

Study the method of collecting a gas, pages 18-19.

LESSON REPORT TO BE WRITTEN FOR CORRECTION

QUESTIONS
(To be answered by all students)

1. Which branch of science is chemistry?
2. What is meant by synthesis?

3. List a few of the things the chemist has done which have helped mankind.

4. What are the states of matter? Give an example of a substance for each state.

5. Explain the difference between as element and a compound.

6. Draw a diagram of as atom and label the parts.

7. Define (a) electron, (b) proton.

8. Which molecules move faster, those at a high or those at a low temperature?

9. Explain diffusion.

10. Describe how a gas may be collected.

----------------------cut off at this line-------------------------

(YOUR NAME)____

(NAME OF COURSE)____________________________________

Exercise 1.

Completion (To be done by all students)

In each of the following examples a word or group of words is missing. Fill in the blank spaces. (Refer to the textbook when necessary.)

1. Metals such as (a)____________,(b)_______________,(c)__________ were known to the Egyptians.

2. The methods of the Greeks were not experimental but_____________. The Greeks' four "elements" were (a)__________, (b)_______________, (c)______________, (d)______________.

3. A process called synthesis has to do with_____________________ ____.

4. Scientific progress increased rapidly during the _____ century and the _________ century.

5. Alchemists argued that gold was the perfect metal because

(a)____

and (b)____

____.

6. According to the alchemists, gold differed from other metals in

___________________.

7. Transmution means ____

____

8. Lavoisier discovered the nature of _________________.

9. Three pioneers in science were (a)________________________,

(b)____________________, (c)___________________________.

(Mail this sheet with the Lesson Report.)

Be sure that your name is on each sheet.

What is Physics? - A beginner in the study of physics often experiences considerable difficulty before he realizes what it is all about. This apparent misunderstanding of the subject is not due to any inherent difficulty of physics but to faulty methods of study.

A scientific definition of physics at this time would be entirely out of place, and the learning of such a definition at the outset would be an excellent example of an improper method of study. That is to say, committing to memory an abstract definition gives one no realization of its meaning. Physics is a study of reality or of real things and not of abstract words about things.

You, whether you have previously studied physics or not, have a fund of knowledge about physical phenomena. Everyone has. Everyone has seen water boil. You undoubtedly have seen water freeze and have seen a hydrometer, a crowbar, a thermometer, a piano, a magnet, an electric light, the rainbow, a house-heating system, a set of pulleys, gears in a machine shop, a steam engine, an automobile engine, the flight of a baseball, and such, but you have probably not attempted to understand the physical principles that underlie these different phenomena. Who has not observed the apparant bend in a pencil, or straight stick, when it is put in a glass of water? In physics we learn why it seems bent. Likewise, who has not made ice cream? In physics we learn how salt facilitates the melting of ice and how the melting of ice freezes the cream.

Physics is thus a study in an orderly way of the causes and the principles underlying many common experiences and observations. To understand these causes and principles one must observe and thus experience the phenomena. Thinking must accompany the observation, that is, relating in one's mind the phenomena observed to other

phenomena and observations previously made or learned. It is in this respect that the study of physics differs from many other school studies. Remembering what the text says about a subject or principle is not enough; one must know the principle irrespective of any form of words in which it may be expressed. To illustrate: water, on freezing, expands; ice, therefore, is lighter that water; and it floats. Suppose the question is: What would happen to our lakes if water contracted on freezing? The answer to this is an obvious deduction from the preceding. No one needs to search the text for an answer. If the water contracted, the ice would sink and gradually the lakes and rivers would become solid ice. Simple, and yet many a student has failed to answer the question because he was afraid to trust his judgment and expected to find the answer in the text. A real knowledge of physics cannot be acquired by a memory process alone; memory must be supplemented by thinking. Most of the principles treated are concrete and not abstract. Make them real. Observe the phenomena and draw your conclusions therefrom.

One author defines physics as the science of measurement. It is undoubtedly true that measuring any physical quantity determines or fixes that quantity. Measurement is the process of comparing a quantity with some arbitrary unit of like quantity. The author of your textbook discusses the fundamental units; other units will be discussed later.

Required Books for the Course.- The books to be used throughout the course are "Modern Physics" by Charles E. Dull, published by Henry Holt and Company, and "Physics Workbook" by the same author. Hereafter the first one will be referred to simply as the Textbook and the other as the Workbook.

How to Study This Course.- The plan of study of this course is not complicated. Merely study thoroughly the assigned pages in the

Textbook and Workbook, together with the supplementary discussions in the pamphlets similar to this one, and do the written work called for under the heading "Lesson Report to be Written for Correction." Your instructor will judge your progress by the written work which you send in for correction. Let your answers be stated clearly, concisely, and convincingly.

You will be allowed as much time as you need for the completion of each lesson. You are urged, however, to study systematically, setting aside a certain nember of hours each week for study. Regularity of study is essential. It keeps alive you enthusiasm, and without enthusiasm your work would lag and grow stale.

You are advised to follow a certain method of study and to take advantage of all "devices" used by the author of the textbook. The whole of physics is divided into large Units as shown in the Table of Contents on page ix of the Textbook. Each Unit is divided into Chapters, each Chapter into Sections, each Section into Paragraphs. For each assignment, you will be required to study two or more sections. First, read the study outline of the sections in the Workbook; then study the sections in the text separately. *Read* one section through completely first and then go back and *study* each paragraph until you feel that you know it thoroughly. Then go on to the next section and proceed in a like manner. When you have finished a chapter, you will find a summary. Study this summary carefully. The list of terms at the end of each chapter should serve as a check on your memory. If you can explain in a sentence or two the exact meaning of each term, your general knowledge of the chapter is sufficient.

The final check on your knowledge, however, comes in answering thequestions at the end of the chapter and in solving the problems

given there. Your "Lesson Report to be Written for Correction" will usually consist of these questions and selected problems. When your corrected lesson reports are returned to you, review them carefully and correct your errors before proceeding to the new assignment.

Spend some time also each week reviewing previous assignments. It is only by review that the subject matter of physics will become a part of you.

Assignment for Study.- Read pages 1 and 2 in the Workbook. Study pages 1-17 inclusive in the Textbook.

Read this assignment by sections. If there are parts that are not clear on the first reading, do not stop but go right on to the end of the section. Read rapidly, yet try to concentrate. You will learn much from this first reading.

Then go back to page 3. Study the vocabulary. When you understand these words, read, then study, paragraphs 1-10. When you feel that you know this section well, go on to paragraphs 11-16. Then study paragraphs 17-21. Pay special attention to words in heavy print and in italics. These are key words.

Study paragraphs 22-24. You must know the metric system well. You spent years learning the English system of measurements. You can learn the metric system in a short time. Study also table 2 on page iv of the appendix. Remember especially:

1 meter = 39.37 inches or 3;28 feet

1 centimeter = .39 inch or .4 inch

1 millimeter = .039 inch or 1/25 inch

1 kilometer = 3280 ft.

1 kilogram = 2.2 lbs.

1 oz.= 28 grams

Next study paragraph 25. Note especially that when stating density you must always state not only the weight, but also the volume; e.g., the density of water is 1 gram per cubic centimeter (1gm./c.c.) or 62.4 lbs. per cubic foot (62.4 lbs./cu.ft.).

Learn the formula for density and be sure you understand it.

Finally check on your accomplishment by using the summary. If there are any words in the list of terms that you cannot explain, look them up again.

LESSON REPORT TO BE WRITTEN FOR CORRECTION

Textbook, pages 17 and 18: Questions 1-10.

Problems 1-6, 12, 17.

Workbook, pages 23-26: Exercises 1 and 2 (Answer all questions).

pages 27 and 28: Test No. 1.

Remove these pages from your Workbook and attach them securely to the rest of your Lesson Report.

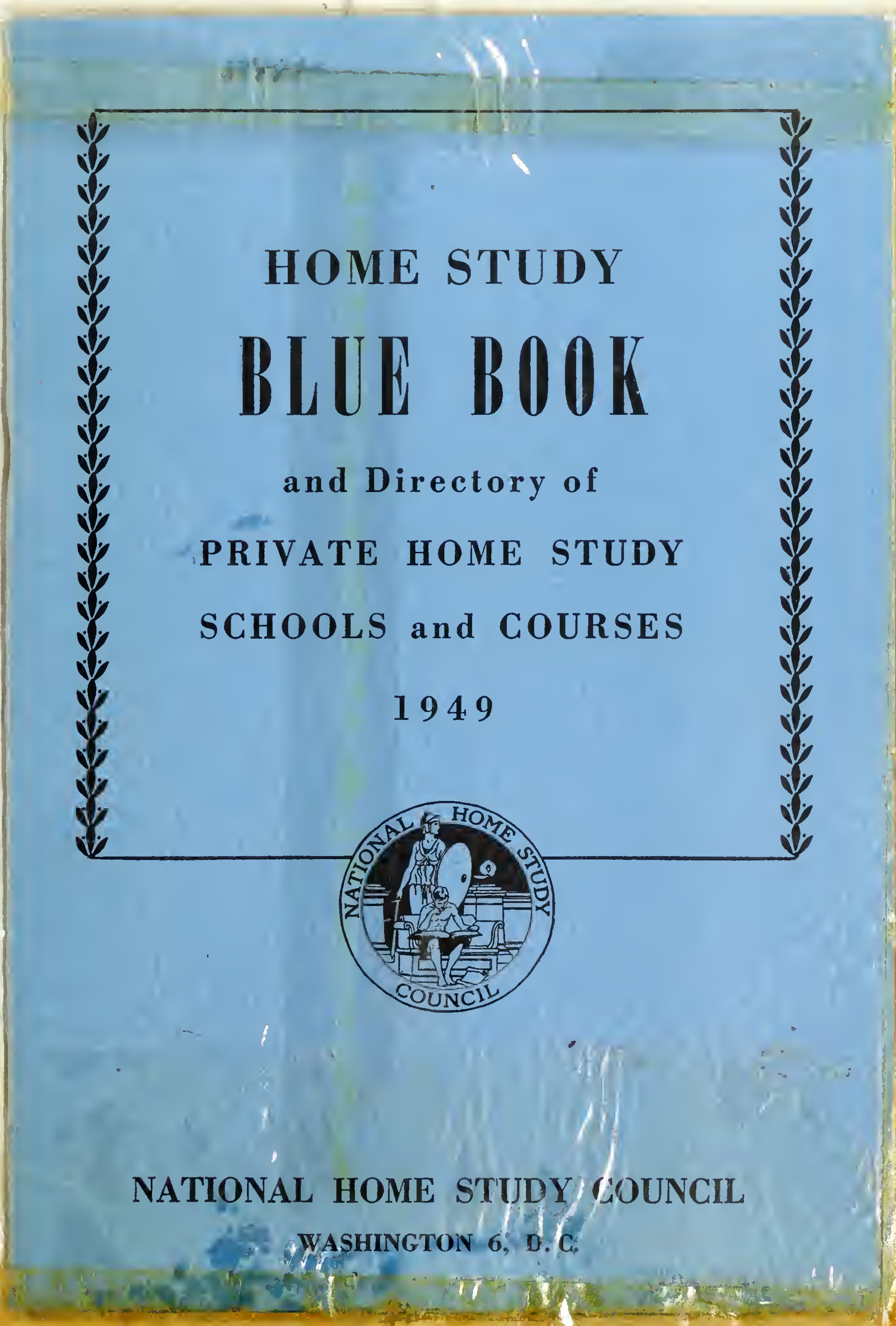
Address your written lesson report to:

Division of University Extension
200 Newbury Street
Boston 16, Massachusetts

Be sure that your name appears on each sheet, including the pages you have removed from your Workbook.

BROCHURE III

PRIVATE HOME STUDY SCHOOLS



HOME STUDY

BLUE BOOK

and Directory of

PRIVATE HOME STUDY

SCHOOLS and COURSES

1949

NATIONAL HOME STUDY COUNCIL

WASHINGTON 6, D. C.

Home Study
BLUE BOOK

Compiled by

J. S. NOFFSINGER, PH. D., DIRECTOR
NATIONAL HOME STUDY COUNCIL

"Quality Spare Time Instruction"

THIRTEENTH EDITION

Published by the
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PART I

Modern Home Study

"The man who utilizes his leisure by studying at home is usually increasing his ability. I can subscribe to that method because I studied that way and know its benefits."—WALTER P. CHRYSLER, Late Pres., Chrysler Corporation, New York City.

Modern Home Study

For more than half a century home study has been meeting the real test of education in the dual capacity of enabling ambitious people to get a better living and in setting before them higher standards of life.

Since the introduction of the spare time study method, the attitude of commerce and industry has undergone a decided change. When more than three quarters of a million ambitious men and women enroll in private schools for home study courses every year, the force of such training will leave its mark upon business and industry quite as surely as it will upon the individual lives of thousands who increase their efficiency and enrich their lives in this way.

Before the advent of the home study method, success for the unschooled man was problematic. Anything beyond a mere living was practically out of the question for the wage earner who, through lack of means, misguided judgment or force of necessity had been deprived of the benefits of a formal education. Lack of early scholastic training need no longer be a serious handicap. Home study has removed the barrier which was once almost insurmountable, so that today any man or woman with a sufficient urge to get out of the rut or away from the blind alley job in which he finds himself, may do so if he wishes. The home study school offers the solution to his problem.

There are also in the busy marts of trade and commerce thousands of high school and college trained men and women who are called upon to perform technical and executive duties for which they lack adequate special training. For these and others aspiring to definite positions of responsibility, the home study school offers an opportunity for thorough instruction in current methods and practices within their respective fields of interest or to which advancement is sought, without necessitating an interruption from business.

Home study is the medium by which they may bring recognition and greater accomplishment within their grasp. It is by far the most satisfactory method yet devised for the great group of people who must prepare themselves for larger success while they continue working for a living or contributing to the living of others.

"Education raises persons above their surroundings and makes them masters of themselves, rather than merely being creatures of circumstances. It is not enough merely to know how to get a living, it is necessary to know how to live."—Former President of the United States.

Airplane View of International Correspondence Schools
Administration Building in Background

The value of training depends on its application. Is home study practical? Go into almost any business organization, any bank, any commercial house, any shop, mill or factory in America today and ask the question of the officers in charge or of the workers. A surprisingly large number of them will confess that their own success in life is due in a great measure to the preparation they secured through spare time study in the quiet of their homes.

Put the question before the tribunal of the American public—or the world public for that matter, and you will have an affirmative declaration concerning the value of spare time training.

What Home Study Means to Employers

The first question asked by the heads of business and industry today is not, "Who are you?" but, "What do you know and what can you do?" Even in the industries where highly specialized operations are in effect there is a constant searching of the ranks for men who are qualified to step out of the purely mechanical jobs and into positions requiring intelligent, creative effort. *Not every man in an organization can be a superintendent or an official, but when every man in a plant or office has a better knowledge of his own particular work and a clearer conception of his company's problems and policies, and a more thorough knowledge of the product it manufactures or sells, there you will find an organization in which labor turnover approaches the zero point and waste and*

> *"Such success as I have had has been very largely due to home study. I have had only one year's schooling since I was less than fifteen years old."*—Editor of an Industrial Magazine.

slip-shod work are negligible items in the overhead. And when every executive in an institution from the top down understands more clearly the relationship of his own work to every other department and the place of his company in the great drama of commerce, there you will find larger net profits and better satisfied stockholders.

What Home Study Does for the Student

Most people take up home study because they see in it an opportunity to make themselves more efficient and therefore more capable of earning a larger income. Thousands have testified to the securing of such results. This aim of securing more money is entirely a praiseworthy one, yet there are other benefits conferred by it which may be of even greater value to the student. Among its *greater* gifts, home study builds character. Every part of every lesson thoroughly mastered by every student, is the requirement of the home study method. The fact that each student must recite each lesson in writing develops a clearness and exactness of thought and expression which are of value in all walks of life. Furthermore, the selfconfidence secured through the process of utilizing leisure moments for definite vocational or professional advancement is probably not second in value even to the knowledge and skills thus secured.

Who Can Advantage by Home Study Courses

We have heretofore thought of education and formal study courses as belonging only to the program of youth. But with the complexity of our modern life and the rapid evolution which is now taking place in every trade, industry and profession, those individuals, whatever their age, that do not keep up with the progress within their own field of endeavor are soon passed by and find themselves engaged in either routine work or relegated to the ranks of the human discard. *Education as it is conceived today is a continuous life process from the cradle to the grave and home study is one of the best methods yet devised of serving ambitious adults with organized study courses after the formal school days of youth shall have passed.*

Among the various groups which could most obviously profit by home study are the following:

1. Young men and women who have finished school, but now being employed, see a definite goal ahead and home study as the direct means of reaching it.
2. Men and women who were deprived of the opportunity of going to school when young.
3. Young men and women who are ambitious but who cannot stop working to go to school.

> "*Achievement is possible to those who have the initiative and determination to equip themselves with knowledge. This requires application and study continued beyond the period of formal school and college courses. But it brings practical results in cultural as well as vocational accomplishment.*"
> —Former President of the Bethlehem Steel Company.

4. Employed men and women who want to better their presnt conditions . . . who need technical or specific training for their present line . . . or who want to get out of a rut or blind alley, perhaps by changing entirely their business, trade or profession.
5. Men and women who want to keep abreast of the time, and to retain and add to the general culture already received in school and college.
6. High school and college graduates who want to continue special training for advanced technical or executive positions.
7. Men and women of junior and senior executive rank, who realize the need of constant refreshing on the fundamentals and newest developments within their respective fields.

Home Study No Competitor of the College

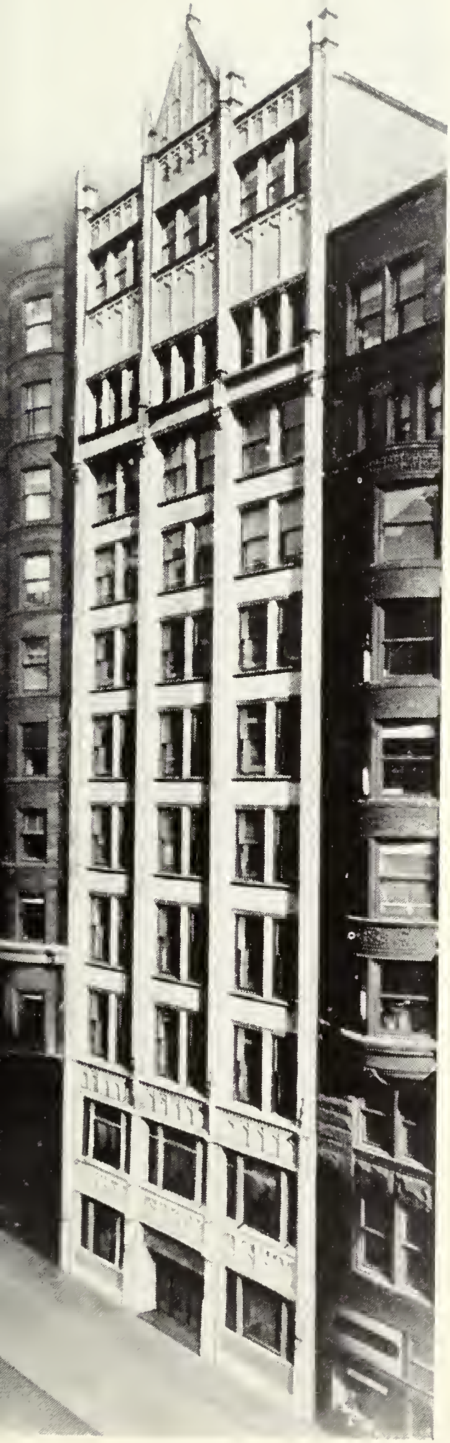
Let this fact be distinctly understood. The home study school in most instances occupies a separate and distinct field from that of the higher institutions of learning, for many with college degrees, wishing to review or to supplement their college training, enroll for home study courses. Home study work is for the most part undertaken by employed men and women who cannot or do not expect to go back again to a resident school. The home study school, therefore, is decidedly not a competitor of the college or resident school.

The application and use to which any training is put determines its value. It is not a matter of the location in which it was derived. Its worth is not a question of Gothic architecture, or ivy-covered walls, or giant stadiums—valuable as all these surroundings are. To the large number who find ambition or opportunity urging them on to greater achievement and larger income, while demanding from them compensatingly more knowledge and ability, our advice is to turn to home study with the assurance that many of the most successful engineers of today secured their training thus; that many business executives learned management and production and business control in the hours that are usually wasted. Many a successful artist and musician likewise learned in the quiet of his own room the fundamental principles of his art, and applied those principles in the development of his present skill. Also many salesmen, accountants, tradesmen and countless thousands of other men and women who have successful businesses of their own, thus learned in their spare time.

Superior Opportunities Offered by Reliable Schools

There is lent a splendid dignity to any institution of learning that is feeding the minds of the earners and doers of the land and whose students and alumni are of a type that dedicate their hours of well earned rest and pleasure to the acquisition of knowledge. The member schools of the National Home Study Council are not in business temporarily. In many instances, through their many years of service to hundreds of thousands and even millions of students, they have built up splendid traditions to which they earnestly adhere. One of these objects is to disseminate immediately usable knowledge and bring it into the life of the

> *"It was through home study that I gained the education I have. I am, therefore, qualified, I think, to testify as to the value of systematic, cultural and vocational home study, and I most heartily commend correspondence study."*—Railroad President.



times. Great practical difficulties and problems have been encountered by these institutions. The students are adult men and women, many of whom are very critical, while others are inclined toward inertia. The training is being paid for out of the students' current income and the things taught are being tested immediately in the intense competition of the daily work.

These conditions have required that the courses of instruction offered exemplify the very best factors in modern education—that they be practical, up-to-date, condensed, clearly presented and in an interesting form. They have required a large expenditure of funds to prepare them and to illustrate them with numerous drawings, cuts, etc.—in many cases to the extent of $100,000 and more for a single course. They have led, also, to the development of the most helpful teaching methods and of a highly trained teaching force. Without doubt some of the best vocational literature and instruction now available in the English language is to be found in these home study courses and certainly no other group of educational institutions devotes more thought and effort to the task of keeping students actively interested and studying.

The home study school has a distinct place in the world's educational system. Texts specially adapted to the student who studies alone, cooperation that serves his needs best, instruction of a peculiar type, to say nothing of the encouragement, the inspiration and the constant effort on the part of reliable schools to bring about the advancement and greater success of their students are among the facilities offered by the reliable schools teaching by the home study method.

Headquarters Building
LaSalle Extension University

PART II

Other Uses For Home Study Courses

There were more than one and one-half million students, mostly adults, actively enrolled during 1948 in one or more of the numerous home study courses which are now available. These students may have enrolled either because of their own desire to utilize leisure time for advancement or they may have enrolled at the suggestion of their employer. The attitude of modern business toward home study courses is shown by the fact that more than 5,000 industrial and commercial corporations, including railroads, banks, manufacturing concerns, department and chain stores, etc., have had some kind of contractual relation with various home study schools for the purpose of "up-grading and training" their employees. In many cases the encouragement to pursue approved home study courses consists of the paying of either a part or all of the required tuition fee for courses which the employee chooses. In other cases, outstanding corporations have arranged for specially prepared home study training courses and have enrolled thousands of their employees therein. This active cooperation and support on the part of organized business and industry is unquestionably the greatest recognition that has ever been given to the practical values of correspondence or home study.

In addition to the above there are a number of other agencies now using home study courses which bid fair to greatly increase the total number of students annually enrolled for this type of instruction. Among these other uses are the following:

In Public High Schools

In 1923 Superintendent Sidney C. Mitchell began experimenting with the use of correspondence courses in the Benton Harbor (Michigan) high school for the purpose of enriching the curriculum with vocational subjects. The experiment proved to be a success and now each high school student in that city has a choice of studying any of several hundred vocational courses by the correspondence plan. The results secured by this method have been declared to be of equal or greater value to that of regular class work and the cost has been found to be much less. Other public high schools have since adopted this so-called "Benton Harbor Plan" and at the beginning of 1941 there were throughout the United States more than two thousand public high schools using this method.

Today (1949) approximately 10% of all the public high schools in the U. S. have now adopted this so-called "Benton Harbor Plan", and tens of thousands

> *"The use of leisure will probably determine whether our civilization is to endure. The place of a home study program in the social scheme therefore becomes obvious, and obviously its importance is not likely to be overestimated."*—Foreign Economic Advisor.

Capitol Radio Engineering Institute

of public high school students have thus and are continuing to pursue an enriched curriculum through the correspondence method of instruction.

In brief the plan is as follows:

1. Designate a director to take charge of the correspondence study department of the school,
2. Establish a connection with one or more correspondence schools offering approved courses of study by the correspondence method,
3. Set aside a double class period each day during which time the student or students will prepare their lessons under the supervision of the director, and
4. When the lessons are prepared they are mailed to the home office of the cooperating home study school for correction and return.

There is some variation from year to year in the list of courses taken by students in the Benton Harbor High School. The following, however, is a typical list:

Course	*Number of Students*
Accounting	1
Advertising	2
Air Conditioning	4
Automobile Engines	25
Automobile Ignition	5
Aviation Engines	10
Aviation—Flight Theory	45
Blue Print Reading	10
Building Contractor	2
Building Wiring	4
Commercial Art	6
Diesel Engines	7
Dress Design	4
High School Subjects	8

> *"Thorough thinking is necessitated by correspondence study work, and initiative, resourcefulness, persistence and thoroughness are qualities cultivated by this plan."*—State University President.

Course	*Number of Students*
Hotel Management	1
Journalism	2
Machine Drafting	25
Machine Lathe	8
Machine Shop Apprentice	40
Photography	2
Practical Nursing	4
Practical Electricity	10
Radio	20
Salesmanship	7
Sheet Metal Drafting	2
Sign and Show Card Writing	2
	256

Several thousand students have now gone through the correspondence department of this one public high school to the entire satisfaction of both the students and the public school authorities.

According to a report of the Michigan State Committee of Education appointed to study this plan, its advantages are described as follow:

1. Any high school can introduce the system regardless of size.
2. It broadens the scope of the high school curriculum.
3. The range of vocational training that the school can provide is almost unlimited.
4. The pupils get exactly the subjects in which they are interested at just the time they are needed.
5. The student may progress as rapidly as his time, energy and ability will permit.
6. The cost to the school system is lower than the ordinary high school subjects.
7. Neither the board of education nor the pupils are bound by any contract.
8. Flexibility. The number of pupils electing any course may vary in number from one to fifty or more.
9. The individual conferences between the director and the pupils provide an excellent opportunity for educational and vocational guidance.
10. The plan is especially valuable in providing the type of instruction needed for the part-time pupils.
11. The work is done under the direct supervision of a high school teacher.
12. The work does not take the place of nor does it conflict with the regular high school work.

The National Survey of Secondary Schools made a study of certain high schools, located in sixteen states, which were offering ninety-five different courses by the correspondence method to their students. The Survey Committee of this Commission reported the following as its findings regarding the advantages of correspondence courses for high schools:

> "On the whole, it is evident that this type of instruction is being used with considerable success by a number of high schools. They are pleased with the results and regard the practice favorably. It is not expensive as compared with the cost of adding to the staff and the equipment. . . .
>
> "There were practically no unfavorable comments. . . . The favorable judgments concerning these lessons would seem to merit further experimentation and use as one means of enriching the program of the high school."

"The many excellent home study courses now available at moderate cost are of inestimable value to persons after their formal education in school has been completed."—Newspaper Editor.

In Junior Colleges, Y. M. C. A.'s and Evening Schools

The junior college is one of the most recent educational institutions to make its appearance in the United States. In 1926 there were 79 of these schools, but twenty-three years later, 1949, their number had increased to 663. These institutions are in reality post graduate high schools and are usually conducted for the benefit of local high school graduates who cannot attend some distant resident college. The courses of study usually demanded by the patrons of these schools are much like the traditional courses found in the first two years of college excepting that a number of vocational subjects are included.

Because of the limitation of finance many of these junior colleges have found it impossible to offer as broad a curriculum as their needs would require. They have, however, found the solution to their problem in the approved correspondence courses which are now available. Certain of these colleges state in their catalogue that they will offer any courses of study whatsoever that may be needed or desired by any of the students. Those students requesting subjects which are not given in residence are enrolled in correspondence courses from approved home study institutions and then carefully supervised and assisted in the preparation of each lesson assignment.

One junior college with a student body of less than one hundred had, in addi-

National Radio Institute

tion to its regular resident classes, students enrolled by correspondence in such subjects as stenotypy, shorthand, advertising, drafting, Greek, Norse, home architecture, interior decorating, accounting, blue print reading, commercial illustrating, astronomy and journalism. Furthermore, the schools which use the correspondence method to enrich their curriculum report that the results thus secured are entirely satisfactory. It is quite probable that the economies effected by this method will eventually result in an increasing use of such courses within this field.

Then again the rapid industrial and commercial evolution through which we have been passing during the last few decades, as noted before, has increasingly demanded of many adults that a portion of their leisure time be spent in a program of continuous readjustment. The Y.M.C.A. and evening high schools have ministered in some of our larger centers to this need. But with decreasing budgets and increasing demands for skilled workers it has become more and more difficult for these public and semi-public agencies to meet all of these needs through class room instruction alone. The correspondence method has therefore been applied to this particular field with notable success. Like in the public day high school, the students are enrolled with an approved correspondence school and then meet to prepare their regular lesson assignments under the supervision of an advisor instead of meeting to hear a lecture as is usual in class room instruction.

Mr. A. W. Castle, Chief of Extension Education in Pennsylvania, has aptly presented the problem confronting the public evening high school and the solution thereto in the following statement:

> "Under our present class-instruction plan, evening high school classes are possible only in communities where the number desiring such courses of study is sufficient to warrant the organization of such classes. The extension of the evening high school program into smaller communities and rural districts must await some complete change of organization and technique in high school work which will enable society to provide educational opportunity of a high school grade for those who desire it without regard to the size of classes. . . .
>
> "If the educational interests of a busy people in a busy age are to be served, some change must be effected. What the ultimate plan will be no one at this time can tell, but of this we may be reasonably certain, the initiation of a comprehensive program of high school correspondence courses of study under the direction of competent teachers—
>
> 1. Would provide the directed learning for which educators clamor.
> 2. Would enable one generally well-equipped teacher to direct the study of many pupils in one group, each pursuing a different correspondence course of study.
> 3. Would supply the sadly lacking differentiation of courses and curricula in all evening high schools.
> 4. Would establish a technique of procedure which would provide differentiation and enrichment of courses and curricula limited only by the needs and desires of pupils.
> 5. Would make it possible for one to carry the evening high-school program out through the smaller cities and boroughs and on to the remote, one-room school building, where perhaps some three to eight or ten individuals might desire to improve themselves by further study, and could pursue their study of as many different correspondence courses under the direction of one teacher."

"Correspondence courses have been of incalculable help to men who have passed the ordinary school-going period but whose experience in gainful employment has made their study much more effective than it could have been at the school-going age."—Editor of a Technical Journal.

Typical Home Study Service Dept.—DeForest's Training, Inc.

In the U. S. Army, Navy, Marine Corps, and Coast Guard

It has been generally recognized that the best vocational home study courses available today are those which have been developed and kept up-to-date through the initiative of the so-called private or commercial correspondence schools.

The United States Government has become the largest single patron of correspondence instruction. Its Armed Forces Institute, with headquarters in Madison, Wisconsin, has made available more than 318 different correspondence courses to members of the U. S. Army, Navy, Marine Corps, and Coast Guard.

Up to August 1948, 1,825,000 service men and women had enrolled for USAFI correspondence courses, many of which were trade and vocational courses furnished by institutions which are listed in this Home Study Blue Book. Needless to say, every course contracted for by the government was adopted only after a thorough investigation.

In Isolated Areas

There are still a number of isolated areas where the population is too scattered to justify the establishment of schools. Such areas are now found in certain Rocky Mountain states, provinces of Western Canada and Alaska, New Zealand,

> *"The value accruing to our American citizenry along cultural and vocational lines by means of home study cannot be overestimated."*—State Superintendent of Public Instruction.

Australia, etc. Public school authorities there have adopted the correspondence method for supplying educational opportunities to children on both the elementary and high school levels. Transportation problems have also isolated many children, and teacher shortages, especially in rural sections, have created serious problems. In many instances, these problems have been met by adoption of home study service.

The American Family Abroad, Shut-ins, etc.

There are thousands of children who are educated entirely by their parents guided by correspondence courses. These include the children of missionaries, government officials assigned to foreign posts, as well as army and navy officers leading transient lives in camps and training stations. Business men representing large American firms are also able to keep their families with them while abroad by enrolling the children in a school offering home-study service. This service is often conducted entirely by air mail. While public schools are making progress in caring for the crippled and shut-in child, there are still thousands of cities and towns where no home service for these pupils is available. This group, through a personalized correspondence service, is made to feel a part of a school though connection with that school may be entirely by letter. One private home study school alone has taught more than 78,000 children and has many records of superior achievement shown by its pupils on return to class-rooms after periods of home study. Units consisting of daily lessons, books and materials are available for kindergarten age upward. As this is being written (Dec. 1948) more than 15,000 American children in Japan—children of our military and civilian occupation forces are pursuing their usual elementary or grade school courses of study through one of the correspondence schools listed in this Blue Book.

Industrial Rehabilitation

Our various states now have programs for the rehabilitation of those who have been vocationally disabled through industrial accidents or otherwise. Prior to 1918 little public interest was shown throughout America for the salvaging through retraining of those who had been thrust upon the "human scrap heap" because of congenital disability or permanent vocational injury received in industry or otherwise. The great number of soldiers vocationally handicapped through injuries received in World War I was the occasion for much study and experimentation within this field. As a result of this experimentation it is now generally accepted by state departments of public instruction that in the rehabilitation of those who are vocationally disabled a new vocation frequently can

> *"An experience of fifty years in engineering practice and the observation of men who have benefited by correspondence instruction leads me to say it is the most powerful factor in true American citizenship, today, and has been the most effective means in standardizing and stabilizing our industries."*—Editor of an Engineering Journal.

best be taught by a course of instruction which includes a period of "placement training" or apprenticeship on the job supplemented by a home study course covering the theoretical aspects of the new vocation or trade to be learned. Many of our states are now generous patrons of home study or correspondence courses for this purpose.

Special Corporation Courses

Few people realize that the courteous service rendered at gasoline and oil stations, chain stores, department stores, etc., which tend to make these places popular, is due in no small measure to the fact that the corporations controlling them have had special home study courses prepared for their employees, setting forth the best methods of display and sales presentation as well as giving a rich fund of factual information about the goods which are handled. The success of these specially prepared courses for individual corporations and industries is shown by the wide range of their use. Among some of the more noted courses of this type are those relating to the sale of gasoline and oil products, automobiles, life insurance, shoes, paints and varnishes, paper, electrical appliances, laundry, printing, department and chain store management, the training of mechanics and service men for particular chain service stations, etc. The economy and uniform thoroughness with which a course of this nature may be administered is making it increasingly popular among the larger corporations and sales organizations.

Detailed information regarding courses of study, schools, etc., which offer their materials through the above listed and other agencies may be secured by addressing an inquiry to the National Home Study Council, Washington 6, D. C.

Chicago Technical College

PART III

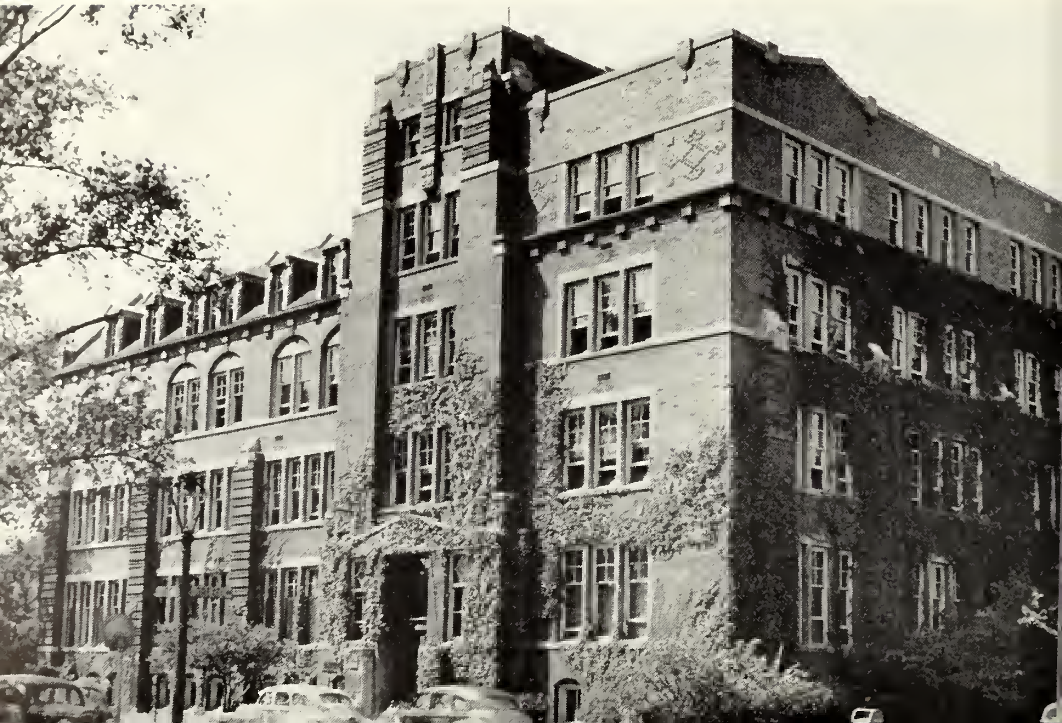
The National Home Study Council

What It Is and What It Aims to Do

The National Home Study Council is a banding together of outstanding home study schools under fair play standards, to protect ambitious people from deception and imposition and to constantly advance the standards of home study instruction. The member schools believe that business in its highest form always seeks to render a service of value to those with whom it deals, while earning a fair profit for itself; and that business not conducted on this basis should not be permitted to exist in this country.

In the interest of the public, as well as in the interest of home study, the National Home Study Council was organized and incorporated in September, 1926, with headquarters at 839 17th Street, N. W., Washington, D. C. The purpose, according to its charter, is the "Promoting of sound educational standards and ethical business practices within the home study field." The object is to cooperate with other interested agencies in making effective a constructive

American School



program designed to curb and eliminate unfair exploitation of ambitious people by unworthy correspondence or home study schools. The great values of home study as offered by the correspondence method were recognized by the recent Carnegie Corporation investigation. It also discovered that there were so-called home study schools which were unethical in their conduct and extremely low in educational standards. Such institutions have too long cast a shadow over home study and the honorable institutions earnestly endeavoring to provide a real educational service.

Certain standards for the advertising and selling of courses, for the educational content of the same, and for the personnel and equipment of approved home study schools have been established by this organization. Briefly stated, these standards are as follows:

Standards

I. Educational Standards

1. Text Materials—The text materials must adequately cover the field claimed, be accurate, be of current value, be well illustrated with descriptive cuts (whenever possible), and be carefully organized and presented in a pedagogical manner.
2. Instruction Services—An adequate staff of competent instructors shall give personal guidance and instructional service to students on each lesson or unit assignment.

II. Ethical Standards

1. The officers and personnel (including the sales organization) of each school is required to have a staisfactory reputation for business and professional integrity.
2. The school is required to be operated in conformity with the Trade Practice Rules for Private Home Study Schools approved by the Federal Trade Commission, November 2, 1936. (The following is a condensation of those rules:)

The following practices and representations by schools are specifically forbidden:

a. The making of false, untrue and deceptive statements regarding
   (1) the actual or probable earnings or opportunities in any vocation or opportunity therein as a result of completion of any given course of instruction;
   (2) the services to be rendered in connection with the securing or attempting to secure employment or a raise in pay or the guarantee of a job upon the completion of a given course of instruction;
   (3) an offer as being "limited" or "special" or "reduced" when in fact it is not;
   (4) the character or credit of a competitor, or the nature, quality, value or scope of his course of instruction;
   (5) the membership of the faculty and the nature of the instruction given; and
   (6) that the school is operated "not for profit."

b. The use of a "money-back" agreement when conditioned upon an improbable contingency, or the use of the word "guarantee" in any connection therewith;

c. The offer of a scholarship or partial scholarship when in fact such offers are not bona fide;

d. Representing that any commodity or service is "free" when in fact such commodity or service is regularly included as a part of the course of instruction or service;

> *"The number of students taking correspondence courses would be multiplied many times if people understood more clearly the results of conscientious study."*—State Superintendent of Public Instruction.

e. The use of any name, title or other designation which does not indicate the true character of the institution or its courses of instruction;

f. The issuance of any certificate, diploma, or degree which misrepresents the course of study covered, or accomplishment or standing of the student receiving it;

g. The use of the "Help Wanted" columns or "blind advertisements" to attract prospective students;

h. The use of papers simulating court documents to effect collection of tuition fees;

i. The use of photographs, cut or illustrations in such a manner as to convey a false impression as to the size, importance or location of the office or building occupied by the school; and

j. Willfully inducing the enrollment or retention of a student for any course of instruction or training for a job for which he is manifestly unfit by reason of education or physical disqualification.

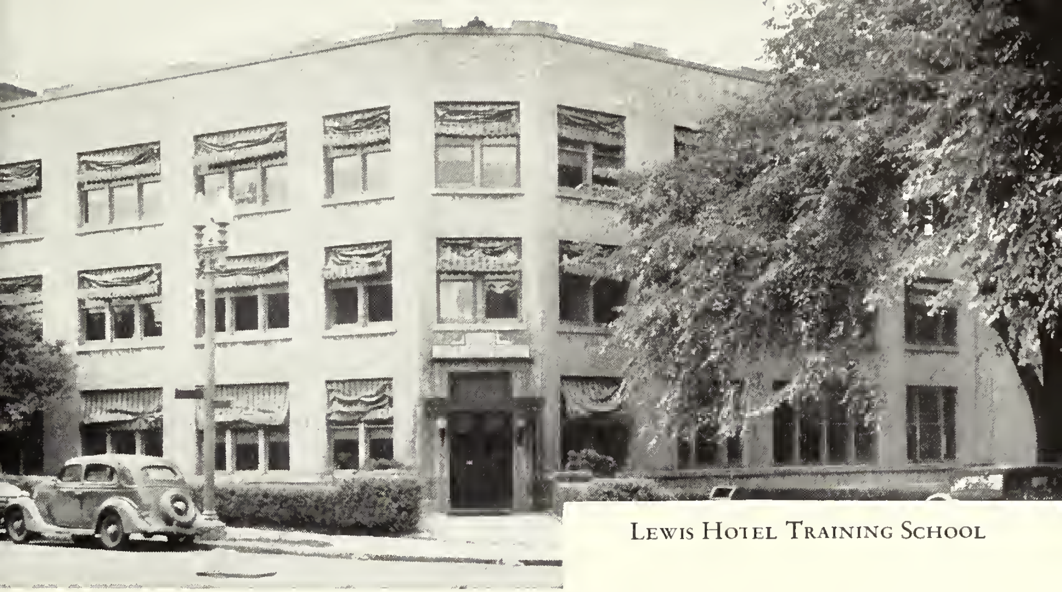
III. Financial Rating

Each school is required to have a satisfactory credit rating and have financial resources sufficient to provide proper service for its announced offerings.

Inspection and Approval of Schools

Every private home study school offering a bona fide course of instruction is not only eligible but is welcome to membership in the National Home Study Council and to listing in the Home Study Blue Book and Directory of Private Home Study Schools. Application blanks may be secured by addressing the

Central Radio and Television Schools



Lewis Hotel Training School

National Home Study Council, 839 Seventeenth Street, N.W., Washington 6, D. C. With the formal application must be filed (1) two complete sets of all current advertising copy, sales literature, form letters, sales talks, collection forms, etc., used by the applicant, (2) one complete set of all lesson papers, texts, assignments, etc., for each course offered, (3) a dozen to fifteen criticized and graded student lesson papers (with stamped, addressed envelopes attached so that after inspection, same might be mailed direct to the student) and (4) a copy of the latest financial statement of applicant. In addition to a thorough examination of the above items, each applicant is also personally visited by an official of the Council to determine whether adequate personnel and equipment are maintained to meet all advertised claims. Thus an inspection covers the thoroughness of the educational and pedagogical standards relating to the construction of textual materials and the servicing of same, and also the ethical practices of the applicant with respect to advertising and selling of scholarships as well as to whether or not the applicant is financially responsible.

Program of the Council

The Council maintains a national office and sponsors a wide program of activities. Among its present activities are: (1) A continuous effort to improve home study technique and methods as well as professional standards of service throughout the entire home study field, (2) cooperation with the Federal and State Departments, Better Business Bureaus, etc., in the establishing of sound ethical practices within the field, (3) the maintenance of a complete cross reference index of all home study courses now available through the various colleges, universities, normal schools, theological seminaries, private schools, etc. This index is the only one of its kind available and is consulted constantly by

> *"In our business of guaranteeing the fidelity of trusted employees, I am always favorably impressed with the man whose application shows his ambition to better equip himself by home study."*—President of a Fidelity Company.

governmental and educational officials, executives, editors, librarians, and individual adults seeking information regarding home study schools and courses, (4) a publicity service to keep the public informed regarding the values of home study and where inspected and approved home study courses may be secured, (5) a clearing bureau to report the technical and professional developments within the field, (6) the holding of annual conventions and conferences for the discussion of home study problems, etc. These activities are maintained by the members of the Council through the payment of dues amounting to approximately 1/6 of 1% of all tuitions received during the previous calendar year.

Consultation Service

As stated above there is maintained at the office of the Council the only complete loose-leaf catalogue of home study courses now available in the United States. This catalogue lists home study courses covering the fields of the various trades and vocations, the liberal arts and sciences and the professions. This service is maintained for the consulting use of adult education organizations, public libraries, colleges and universities, commercial and industrial corporations, chambers of commerce, public school officials, educational departments of newspapers and magazines and other similar organizations, as well as for individuals who are desirous of learning where approved home study courses may be secured in any desired subject or vocation. A list of recommended home study schools offering courses in any given field or subject will be sent to any one *sending a stamped, addressed envelope with the request:*

"Send a list of recommended schools offering home study courses in
(Name of subject or vocation)

to the **NATIONAL HOME STUDY COUNCIL**
839 SEVENTEENTH ST., N. W.
WASHINGTON 6, D. C.

Home of National Schools

PART IV

Directory of Approved Schools and Courses

Approved Schools

The following home study schools have been approved to date, and are believed to be operating in harmony with the standards set forth. These schools constitute the membership of the National Home Study Council.

1—Air Conditioning Training Co., 789 Wick Ave., Youngstown 1, Ohio
2—American Landscape School, 6015 Grand Ave., Des Moines 12, Iowa
3—American School, Drexel Ave. at 58th St., Chicago 37, Illinois
4—American School of Photography, 1315 S. Michigan Ave., Chicago 5, Illinois
5—American Technical Society, 850 E. 58th St., Chicago 37, Illinois
6—Art Instruction Inc., 500 S. 4th St., Minneapolis 15, Minnesota
7—Calvert School, Tuscany Road, Baltimore 10, Maryland
8—Capitol Radio Engineering Institute, 3224—16th St., N.W., Washington 10, D. C.
9—Central Radio & Television Schools, Inc., 17th and Wyandotte, Kansas City 8, Mo.
10—Chicago School of Nursing, 41 East Pearson Street, Chicago 11, Illinois
11—Chicago Technical College, 2000 S. Michigan Ave., Chicago 16, Illinois
12—Commercial Extension, 16th and Howard St., Omaha 2, Nebraska
13—De Forest's Training, Inc., 2533 N. Ashland Ave., Chicago 14, Illinois
14—Hemphill Diesel & Automotive Schools, 1601 S. Western Ave., Los Angeles 6, Calif.
15—Hill's Extension School, 619 W. Main St., Oklahoma City 2, Oklahoma
16—Industrial Training Institute, Inc., 2150 Lawrence Ave., Chicago 25, Illinois
17—Institute of Applied Science, 1920 Sunnyside Ave., Chicago 40, Illinois
18—International Accountants Society, Inc., 209 W. Jackson Blvd., Chicago 6, Illinois
19—International Correspondence Schools, Scranton 9, Pennsylvania
20—LaSalle Extension University, 417 S. Dearborn St., Chicago 5, Illinois
21—Lewis Hotel Training School, 2301 Penna. Ave., N.W., Washington 7, D. C.
22—Lincoln Extension Institute, W. 75th St. at Detroit Ave., Cleveland 2, Ohio
23—Methods Engineering Council, 822 Wood St., Pittsburgh 21, Pennsylvania
24—National Baking School, 1315 S. Michigan Ave., Chicago 5, Illinois
25—National Poultry Institute, Adams Center, New York
26—National Radio Institute, 16th and U Sts., N.W., Washington 9, D. C.
27—National School of Dress Design, 1315 S. Michigan Ave., Chicago 5, Illinois
28—National Schools, 4000 S. Figueroa St., Los Angeles 37, California
29—Newspaper Institute of America, 1 Park Ave., New York 16, N. Y.
30—New York Institute of Photography, 10 W. 33rd St., New York 1, New York
31—North American School, 1315 S. Michigan Ave., Chicago 5, Illinois
32—Palmer Institute of Authorship, 1680 N. Sycamore, Hollywood 28, California
33—Perry Business Schools, Brunswick, Georgia
34—Plastics Industries Technical Institute, 1601 S. Western Ave., Los Angeles 6. Calif.
35—Storycrafters Guild, 5617 Hollywood Blvd., Hollywood 28, California
36—Universal School of Commerce, 4610 W. 59th St., Mission, Kansas
37—University Extension Conservatory, 28 E. Jackson Blvd., Chicago 4, Illinois
38—Utilities Engineering Institute, 2525 N. Sheffield Ave., Chicago 14, Illinois
39—Walton School of Commerce, Wabash at Washington, Chicago 2, Illinois
40—Wayne School of Practical Nursing, 2525 N. Sheffield Ave., Chicago 14, Illinois
41—Weaver School of Real Estate, 15 East Pershing Road, Kansas City 8, Missouri

> *"For many years past I have been an advocate of home study. I know many college graduates who have taken up correspondence courses after graduation largely in technical subjects, and who have advanced themselves in so doing."*
> —President of a Southern Railroad.

Plastics Industries Technical Institute

Courses Offered By Approved Schools

The following is a partial list of home study courses now offered by schools which have been inspected and approved by the National Home Study Council. The numbers placed after each of the following courses indicate the school or schools which offer that course. (See list of schools on preceding page.) Complete information regarding courses of study may be secured by addressing a letter to the school offering same. The fact that two or more schools may offer courses of instruction bearing the same or similar title and approved by the Council *does not mean that those courses are of equal merit.* It only means that each school truthfully describes its offerings and that the fees charged are reasonable for the instruction and services rendered.

ACCOUNTANCY
Accountancy 3-5-15-18-19-20-36-39
Advanced 3-15-18-19-20-39
Auditing 3-15-18-19-20-39
C.P.A. Coaching 15-18-19-20-39
C.P.A. Problems and Business Law 15-18-19-20-39
Cost 3-15-18-19-20-39
Hotel 21
Income Tax Procedure 15-18-19-20-39
Junior 3-19
Law Accounting 18-20
Mergers and Consolidations 39
Municipal 39
Public Auditing 15-18-20
Secretarial 19-20
Small Business Record Keeping 19
Stock Brokerage 39
Systems 18-19-20-39

ADVERTISING
Advertising 3-19-20
Advertising Direct Mail 19
Advertising—Production Management 19
Copy Writing 19
Newspaper Advertising 19
Retail and Department Store 3-19
Sales Letter and Circular Writing 19-20

AGRICULTURE
Agriculture 3
Farm Engineering and Management 20
Poultry Farming 25
Poultry Judging and Breeding 25

AIR CONDITIONING
Aid Conditioning 1-3-5-16-19-38
Air Conditioning, Railroad 3-5-19
(See also Heating and Ventilating)

APPRENTICE COURSES
Boilermaker 3-19
Bricklayer 3-11-19
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"*Persons of the highest intelligence never cease to learn, and any person, whatever may be his station in life, who devotes a share of his time to self-betterment through home study courses, or otherwise, will never regret the time thus spent.*"—President of a Western Railroad.

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UTILITIES ENGINEERING INSTITUTE

PART V

What Others Say About Home Study

The following statement regarding correspondence schools is taken from the report on "Adult Education" presented at the second annual conference of the American Vocational Association:

"1. Correspondence Schools were forerunners in the movement for adult education.

"2. They have rendered educational service in many forms and on a large scale when this service was, generaly speaking, not available to employed people in many communities and some of which was not available in any community.

"3. To the degree that this home study work has been efficiently conducted, they have reached and helped millions of citizens who would otherwise never have been helped by any other agency.

"4. Their agents, even though admittedly spurred by the commercial motive, have sold educational service to thousands of citizens who probably would never have been reached by the more formal academic methods of professional school men.

"5. There is abundant evidence that this service has set the feet of many people on the road to more successful careers.

"6. They will continue to develop every neglected spot in a democratic program of adult education, and, in our opinion, find always a large and legitimate field in which they will supplement the efforts of public and privately endowed agencies."

Former U. S. Commissioner of Education—"These institutions which offer a practical working knowledge of modern business to adults, through extension methods, perform a praiseworthy piece of the world's work."

Former University President—"When we consider the home study courses that are available today we must admit that the marvel of the age is not the aeroplane, but education."

State Commissioner of Education—"It is not in schools that we are educated but in the school life, and home study is the essential part of the curriculum."

President of a State University—"I am inclined to think that many adults after their first home study course are filled with regret that they had not sooner found this source of real pleasure and profit."

President of a Large Industrial Corporation—"In my opinion the work performed through home study courses is very beneficial, both to the individual taking them and the country as a whole, and is deserving of hearty encouragement and support."

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Dr. Russell H. Conwell, the late President of Temple University—"The faculties of correspondence schools of national standing compare favorably with those of universities. Their influence penetrates to the remotest quarters of the country. That means the open door to the best instruction for everybody."

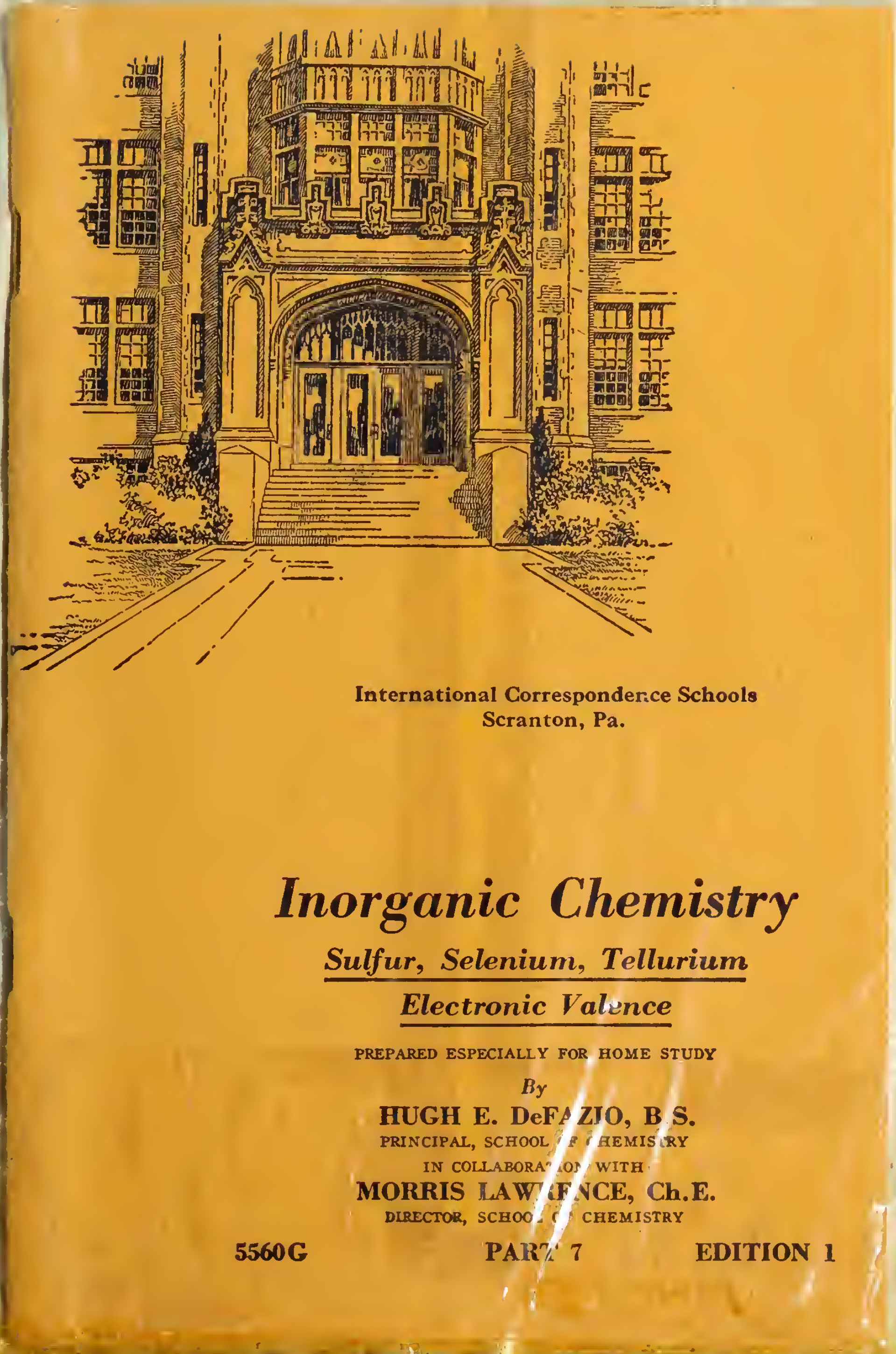
Theodore Roosevelt—"I look upon instruction by mail as one of the wonderful and phenomenal developments of this age."

Government Bulletin 1920, *No.* 10, *Bureau of Education*—"For those wishing intensive study in a single branch or two, classroom work is not adapted. Students must often take three or four studies to get the one they wish; they must not go faster than the class and the work must be managed in the interest of the group, not the individual. This makes correspondence study especially desirable for those who wish instruction in special subjects allied to their everyday life. The correspondence course permits them to select what will serve their purposes without doing work that to them is useless or an old story, although required by the courses planned for group instruction."

The above insignia appearing on descriptive literature, stationery or in catalogues of any correspondence school indicates that the institution has been approved by and is a member of the National Home Study Council

BROCHURE IV

INTERNATIONAL CORRESPONDENCE SCHOOLS



International Correspondence Schools
Scranton, Pa.

Inorganic Chemistry

Sulfur, Selenium, Tellurium

Electronic Valence

PREPARED ESPECIALLY FOR HOME STUDY

By

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IN COLLABORATION WITH
MORRIS LAWRENCE, Ch.E.
DIRECTOR, SCHOOL OF CHEMISTRY

5560G **PART 7** **EDITION 1**

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INORGANIC CHEMISTRY

(PART 7)

Serial 5560G Edition 1

SULFUR FAMILY

GROUP RELATIONSHIPS

1. The sulfur family consists of the following three elements: sulfur, selenium, and tellurium. With oxygen, they occupy group VI B of the Periodic Table. However, since they are more closely related to one another than they are to oxygen, they are discussed separately. The atoms of sulfur, selenium, and tellurium possess six electrons in their outermost, or valence, shell. Like the halogens, the atoms of these elements tend more strongly to acquire the additional electrons required to complete the stable octet (valence shell) than to lose any of the electrons. Because of this fact, they exhibit a negative valence of 2 in their most stable compounds. Sulfur, selenium, and tellurium, however, do form compounds in which they exhibit a positive valence, indicating that their atoms lose electrons.

2. The foregoing elements are all solids that have relatively low melting points. Sulfur and selenium are distinctly non-metals; tellurium, although a non-metal, exhibits certain metallic properties. Although there is a great similarity between the chemical nature of these elements and those of the halogens, they are much less active. Their activity, like that of the halogens, decreases with an increase of atomic weight.

3. Sulfur, selenium, and tellurium form binary compounds with metals and hydrogen, in which they exhibit a valence of -2. These compounds are less stable than those of the corresponding compounds of the halogens, and, because of this fact, the sulfur, selenium, and tellurium may be easily oxidized to the free state. When oxidized by strong oxidizing agents,

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they form compounds in which they exhibit positive valences The valences of +4 and +6 are the most important positive valences.

SULFUR

EXTRACTION, PROPERTIES, AND REACTIONS

4. History and Occurrence.—Sulfur was one of the first elements known. It is mentioned in the Bible by the name of brimstone, which means burning stone. The deposits in Sicily were known to the Romans. The Romans and the Greeks used sulfur in medicine; they also used the fumes of burning sulfur to bleach textiles and for fumigation. Lavoisier classified sulfur as an element in 1777.

Sulfur is found free in many parts of the world. In Sicily, large deposits are found mixed with gypsum, $CaSO_4 \cdot 2H_2O$, and other minerals in the pores of pumice. Small deposits of sulfur occur in Iceland, Mexico, Spain, and Japan. The most extensive deposits of sulfur, however, are found at the present time in Louisiana and Texas.

5. Sulfur is also found combined with many elements in many minerals. Although these minerals are important chiefly because of their other constituents, many of them are used as sources of sulfur compounds. The sulfides and sulfates are the most plentiful sulfur compounds, of which the following are examples:

SULFIDES		SULFATES	
NAME	FORMULA	NAME	FORMULA
Pyrites	FeS_2	Gypsum	$CaSO_4 \cdot 2H_2O$
Copper pyrites	$CuFeS_2$	Barite	$BaSO_4$
Galena	PbS	Celestite	$SrSO_4$
Zinc blende	ZnS	Epsomite	$MgSO_4 \cdot 7H_2O$
Chalcocite	Cu_2S	Chalcanthite	$CuSO_4 \cdot 5H_2O$

Sulfur occurs in many organic compounds. It is a constituent of the proteins, which are important components of plants and animals.

6. Industrial Production of Sulfur.—In Sicily the deposits of sulfur occur mixed with limestone and gypsum. The sulfur is separated from the limestone and gypsum by heating the ore in circular kilns called *calcaroni*. The amount of sulfur present in the ore varies from 10 to 30 per cent; when the ore is heated, the sulfur melts away from the accompanying volcanic rock and flows down the sloping floor of the kilns. Because there is no coal in Italy and the available fuels are too expensive, part of the sulfur is used as fuel. Some sulfur is burned and the heat produced melts the rest of the sulfur at the bottom of the kiln.

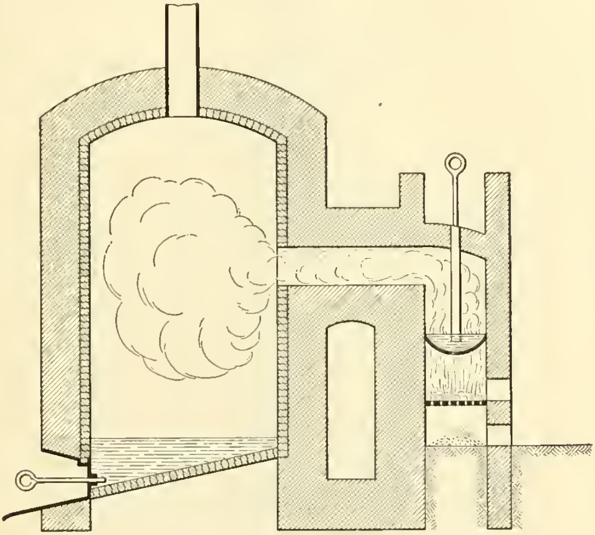


FIG. 1

The liquid sulfur flows into wooden molds, in which it solidifies in the form of roll sulfur. This sulfur contains a small percentage of impurities, but it is sufficiently pure for many purposes. A good share of it is used in the making of sulfuric acid and in other processes that do not require pure sulfur.

7. The impure sulfur is refined by distillation from iron retorts into large brick chambers, Fig. 1. At the beginning of the distillation, when the chambers are cold, the sulfur vapor condenses upon the walls and floors of the chambers in the form of a fine powder, called flowers of sulfur. After the chambers have been heated, the sulfur vapor condenses as a liquid and is drawn off into molds, in which it solidifies in the form of roll sulfur.

8. Frasch Process.—In America the deposits of sulfur, which are now the chief source of the world's supply of sulfur, are from 500 to 1,500 feet deep. The deposits are located underneath strata of clay, quicksand, and rock. Because of the strata concerned and the quantities of hydrogen sulfide and sulfur dioxide which occur in shafts sunk into the sulfur-bearing stratum, the extraction of sulfur by ordinary mining or tunneling is impossible. After 10 years of investigation, Herman Frasch, an American chemist, developed a very ingenious and successful method of extracting the sulfur. The process consists essenti-

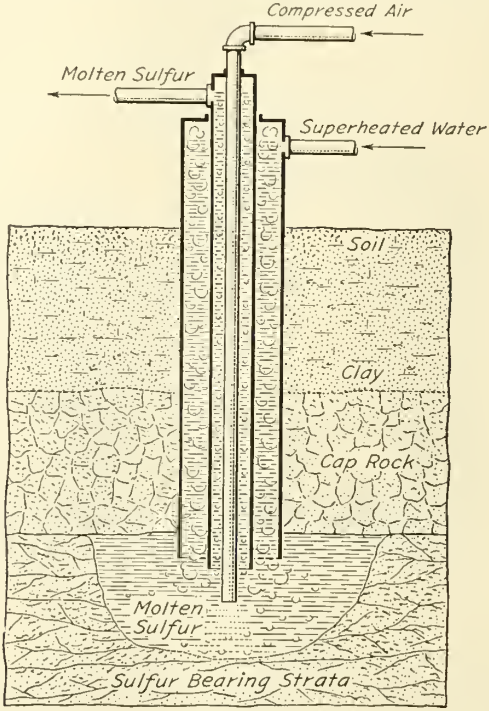


Fig. 2

ally of melting the sulfur in the sulfur stratum by superheated water, and then raising the liquid sulfur to the surface by means of compressed air.

9. Wells consisting of three concentric pipes, Fig. 2, are sunk to the bottom of the sulfur stratum. The superheated water, at a temperature of about 175° C. and under a pressure of about 200 pounds per square inch, is forced down the outer pipe, which is 6 inches in diameter; and the compressed air, under a pressure of about 400 pounds, is forced down the innermost pipe, which is 1 inch in diameter. The superheated water melts the sulfur and the compressed air forces the molten sulfur up the middle pipe, which is 3 inches in diameter. The molten sulfur is collected in large bins, where it solidifies into enormous solid blocks. The solid mass is subsequently broken up and shipped to various industrial centers that use sulfur. The sulfur produced by this process is of such a high degree of purity, more than 99.5 per cent, that for most purposes there is no need of any further purification. A single well produces as much as 2,000 tons of sulfur in one day.

10. Allotropic Forms of Sulfur.—Sulfur exists in several forms that differ from each other in physical properties. It may occur in two well-known solid forms, in two different liquid forms, and in the vapor state. Such variation in the physical properties of an element is called allotropy, and the different forms of the element are called allotropic modifications. The allotropic forms capable of existing at room temperature are the rhombic sulfur, monoclinic sulfur, and amorphous sulfur. The rhombic and monoclinic sulfur are two distinct and different forms of crystals. In order to understand clearly the discussion of these and any other crystalline forms of different elements, the following information on crystals is presented.

11. Crystals.—Crystals are substances of definite symmetrical or geometrical form. A solid, homogeneous substance may exist in either the amorphous or the crystalline state. However, in the majority of cases, solid substances are found to exist in the crystalline state. A crystal is correctly defined as a solid substance that has a definite geometrical shape with flat faces and sharp edges, whereas an amorphous substance is a solid without a definite shape, such as flint or glass.

12. A very essential property of crystals is that every crystalline substance has a specific crystalline structure, or form, which is characteristic of that substance. If crystals having the same chemical composition are examined, the faces may be found to vary in size and shape; but, if they are at the same temperature, the interfacial angles will be found to have the same numerical value. To state it differently, the interfacial angles of crystals having the same chemical composition are exactly the same, and they are characteristic of that substance.

13. Other characteristic properties of crystals are cleavage and double refraction. Cleavage is the property of splitting along certain definite directions or planes. The cutting of diamonds is an application of cleavage. Although the diamonds are intensely hard, they may be readily split along the cleavage planes. Double refraction is the property of allowing heat and light rays to pass more readily in certain directions than others.

Substances that crystallize in the same form, such as the sulfates of zinc and magnesium, are isomorphous substances; substances, such as sulfur, that are capable of crystallizing in two forms are dimorphous.

14. Classification of Crystals.—The great variety of crystals formed by different substances have been classified into seven systems and thirty-two distinct classes. Since the study of crystals is a special branch of science known as crystallography, it will suffice merely to indicate the general principles on which the classification is based. The classification of the different crystalline forms is carried out according to the characteristic properties that are peculiar to the members of the seven systems into which the crystals can be arranged. For instance, the planes of symmetry are characteristic of each class. A plane of symmetry is an imaginary plane that divides the crystal into two parts, one part being the exact but inverse counterpart of the other. The two parts bear the same relation to one another that a mirror bears to its object, the mirror being equivalent to a plane of symmetry. For example, an examination of a crystal of sodium chloride, Fig. 3, will show that nine planes of symmetry are possible. Three planes are shown and the other six may be obtained by drawing diagonal planes through three faces of the cube. Crystals may have one, three, five, seven, or nine planes of symmetry, and there are crystals with no planes of symmetry.

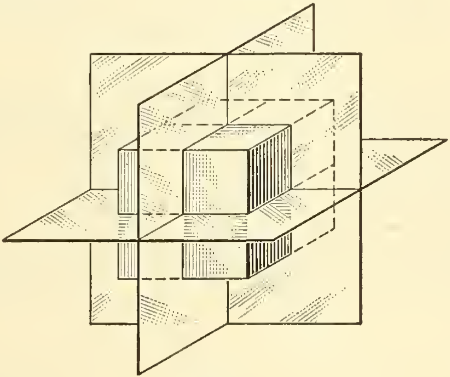


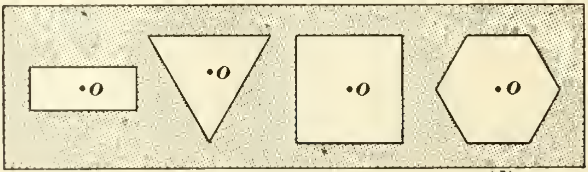
Fig. 3

15. Crystals also possess the property of being able to be rotated about a definite axis through an angle such that the aspect of the crystal is the same as before the rotation. The axes of rotation are called axes of symmetry. Crystals may have two, three, four, or six positions of symmetry during a complete rotation. Hence, the terms, dyad, triad, tetrad, and hexad axes of symmetry are used. The different axes of symmetry are illustrated in Fig. 4. A horizontal cross-section of a crystal with a dyad axis of symmetry is shown in view (*a*). This is true because, during the rotation of the crystal about the axis *O*, there are only two positions in which the original aspect of the crystal is the same. Crystals having triad, tetrad, and hexad axes of symmetry are shown in views (*b*), (*c*), and (*d*), respectively.

16. Systems of Crystallization.—The names of the seven systems and examples of each system are as follows:

Cubic System.—The cubic system is also called the isometric, or regular, system. The crystals in this system have nine planes of symmetry and they comprise five different classes. Sodium chloride, alum, potassium chloride, and the diamond are examples of substances that crystallize in this system.

Tetragonal System.—The tetragonal system is also called the quadratic, or pyramidal, system. The crystals have five planes of symmetry and the system includes seven different classes of crystals. Mercurous chloride, zircon, potassium hydrogen phosphate, and tin are examples of substances that crystallize in this system.



(a) (b) (c) (d)

FIG. 4

Hexagonal System.—The crystals of the hexagonal system have seven planes of symmetry. The system comprises five classes of crystals, of which those of quartz and lead iodide are very good examples.

Trigonal System.—The trigonal system is also called the rhombohedral system. The crystals have three planes of symmetry and the system includes seven classes of crystals. Sodium periodate, antimony, bismuth, graphite, and arsenic are examples of substances that crystallize in this system.

Rhombic System.—The rhombic system is also called the orthorombic, trimetric, or prismatic system. The crystals have three planes of symmetry and the system includes three classes of crystals. Magnesium sulfate, potassium sulfate, and zinc sulfate are examples of substances that crystallize in this system.

Monoclinic System.—The monoclinic system is also called the monosymmetric, or the oblique, system. The crystals have two planes of symmetry and the system includes three classes of crystals. Gypsum, borax, sodium carbonate, and sodium sulfate are examples of substances that crystallize in this system.

Triclinic System.—The triclinic system is also called the asymmetric, or the double oblique, system. The crystals of this system have neither planes nor axes of symmetry. The system includes two classes of crystals, of which those of copper sulfate and potassium dichromate are good examples.

17. Rhombic Sulfur.—Rhombic, or ordinary roll, sulfur is the more common crystalline form. It is composed of rhombic crystals, the shape of which is shown in Fig. 5. Well-defined rhombic crystals may be obtained by allowing sulfur to crystallize from solution in carbon disulfide. A sample of sulfur is powdered and dissolved in carbon disulfide. The solution is then filtered and the filtrate is allowed to evaporate slowly in an evaporating dish. As the solution begins to evaporate, the rhombic crystals start to form. They are octohedral, transparent, and amber colored. These crystals have a specific gravity of 2.06 and melt when heated rapidly at 114.5° C. Rhombic sulfur is the stable modification below 95° C., and all the other allotropic modifications, on standing below this temperature, pass into the rhombic form.

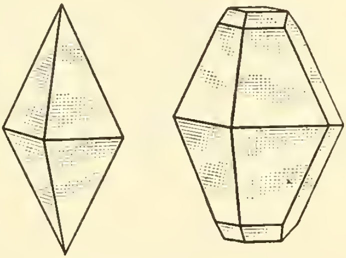


FIG. 5

18. Monoclinic Sulfur.—Monoclinic sulfur is the stable solid form between 95° C. and 120° C., and may be prepared by crystallization within this range of temperature. Well-formed crystals of monoclinic sulfur can be obtained by melting sulfur in a porcelain crucible and allowing the mass to stand until a surface crust is formed. After the surface crust is formed, long transparent and prismatic needlelike crystals of sulfur, Fig. 6, will be found to have formed on the walls of the crucible. If the crust is pierced and the still fluid sulfur is poured off, the monoclinic crystals will also be found on the under side of the crust. The crystals have a specific gravity of 1.96, melt at 120° C., and are soluble in carbon disulfide. When monoclinic sulfur is allowed to cool, it gradually changes into the rhombic form. On the other hand, when the rhombic form is heated above 95° C., it changes to the monoclinic form. This reaction is reversible and its direction depends upon the temperature. Experiment has shown that the monoclinic sulfur is unstable below 95° C., slowly passing into the rhombic form; also that the rhombic sulfur is unstable above 95° C., slowly passing into the monoclinic form. This transformation may be represented as follows:

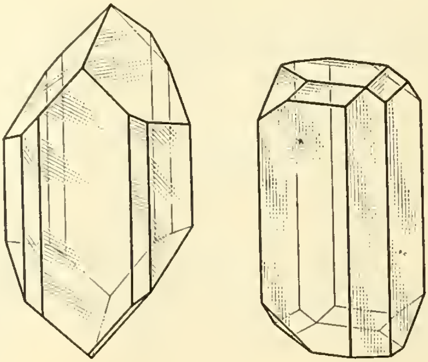


FIG. 6

$$S \text{ (rhombic)} \underset{}{\overset{95^\circ \text{ C.}}{\rightleftarrows}} S \text{ (monoclinic)}$$

Because of this fact, it can be readily seen why all of the sulfur found free in nature is of the rhombic form.

19. Amorphous Sulfur.—Amorphous sulfur may be prepared by pouring molten sulfur that has been heated to about 350° C. into cold water. The spongy mass obtained by suddenly chilling the molten sulfur is called plastic sulfur and, since it has no crystalline form, it is also called amorphous sulfur. The specific gravity of amorphous sulfur is 1.95, almost the same as that of monoclinic sulfur; but, unlike the crystalline forms, amorphous sulfur is not soluble in carbon disulfide. It is probably a supercooled liquid that has been formed by suddenly cooling the molten sulfur below its crystallizing temperature. Experiment has shown that this variety of sulfur is unstable and that, after standing for any length of time, it begins to change to the rhombic form.

20. Physical Properties of Sulfur.—Sulfur is a pale-yellow, brittle solid having a specific gravity of 2.07. All forms of sulfur are insoluble in water, and they are all non-conductors of heat and electricity. When heated to a temperature of about 114° C., the sulfur melts to form a clear, mobile, amber-colored liquid, called α-sulfur. As the temperature rises, the liquid loses its mobility and, at a temperature of about 160° C., a dark-brown viscous fluid, called μ-sulfur, is formed. The viscosity reaches its maximum at about 200° C. and, as the temperature continues to rise, the dark color remains, but the viscous liquid becomes more and more mobile until at 444.6° C. the liquid begins to boil, forming an orange vapor. The molecular formula of dissolved sulfur is S_8. However, at 1000° C. the vapor density corresponds to the formula S_2, and at 2000° C. the vapor density corresponds to the monatomic formula S.

21. Chemical Properties of Sulfur.—At ordinary temperatures, sulfur is a relatively inactive element; but, when heated, it combines with most metals to form sulfides. For example,

$$Zn+\mathrm{S} \longrightarrow ZnS$$
$$Fe+S \longrightarrow FeS$$
$$2Cu+S \longrightarrow Cu_2S$$

Sulfur also combines with certain non-metals, particularly oxygen and chlorine. It burns in air with a bluish flame, and in oxygen it burns with a brilliant flame. In both cases, sulfur dioxide is formed.

$$S+O_2 \longrightarrow SO_2$$

Sulfur monochloride, S_2Cl_2, is formed when chlorine and sulfur combine. When sulfur vapor is passed over red-hot coal, carbon disulfide, CS_2, is formed. This reaction is similar to that of the formation of carbon dioxide, CO_2, where oxygen is used instead of sulfur.

22. Industrial Applications of Sulfur.—Sulfur is used extensively as a basic material in the arts and in various manufacturing and industrial processes. It is burned to form sulfur dioxide, which is used in the manufacture of sulfuric acid, in the bleaching of straw and wool, and in the production of sulfite liquor that is used in the paper industry for the manufacture of different types of pulp. Large quantities of sulfur are used in the production of vulcanized rubber, and in the manufacture of sulfides used in certain kinds of synthetic rubber. It is used in the manufacture of matches and in the production of enamels and cement. A cement suitable for sealing rods in concrete or stone is made by mixing hot sand with molten sulfur. Purified sulfur is used in medicine and in industrial organic chemistry for the manufacture of dyes. Sulfur is also used in the production of carbon disulfide, in the manufacture of gunpowder, and as an insecticide.

HYDROGEN SULFIDE

23. History and Occurrence.—Hydrogen sulfide, H_2S, known also as sulfureted hydrogen, was discovered by Scheele in 1777. It occurs as the essential constituent of many mineral waters (sulfur springs) and is present in the gases expelled by volcanoes during eruption. Hydrogen sulfide is always one of the products formed when any animal or vegetable matter containing sulfur decomposes.

24. Preparation.—Hydrogen sulfide may be easily prepared in the laboratory by treating ferrous sulfide, FeS, with a dilute solution of hydrochloric or sulfuric acid. The ferrous sulfide may be prepared by strongly heating a mixture of iron and sulfur.

$$Fe + S \longrightarrow FeS$$

When ferrous sulfide is treated with dilute hydrochloric or sulfuric acid, the metallic salt of the respective acid forms and hydrogen sulfide is liberated. Thus,

$$FeS + 2HCl \longrightarrow FeCl_2 + H_2S \uparrow$$
$$FeS + H_2SO_4 \longrightarrow FeSO_4 + H_2S \uparrow$$

Hydrogen sulfide gas is poisonous and should be generated in a hood. By using a very little acid at a time, excessive generation can be avoided. The evolution of the gas can be stopped by pouring off the acid into a drain and leaving the ferrous sulfide in the generating flask.

25. The hydrogen sulfide gas can be collected in an apparatus similar to the one shown in Fig. 7. A few lumps of ferrous sulfide are placed in the generating flask *a*, and the dilute acid is added from the dropping funnel *b*. Enough acid should be added to cover the ferrous sulfide and to reach the bottom of the dropping funnel. This precaution is taken in order to prevent the escape of the gas through the dropping funnel, the acid acting as a liquid seal. When the dilute acid comes in contact with the ferrous sulfide, hydrogen sulfide gas is immediately generated. The gas is led through the wash bottle *c*, and then into the receiving flask *d*, which contains water or ammonium hydroxide, depending on whether a solution of the gas in water or a solution of ammonium sulfide is desired. The reaction between hydrogen sulfide and ammonium hydroxide is represented by the following equation:

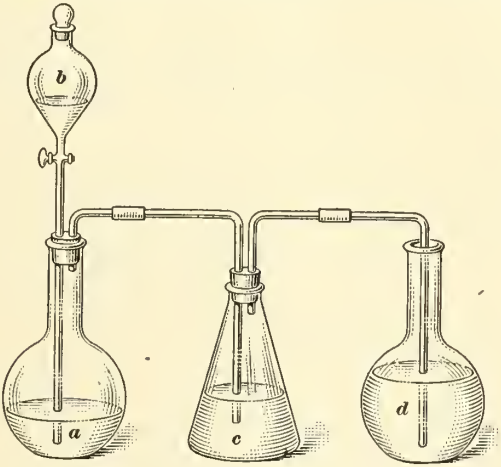


FIG. 7

$$H_2S + 2NH_4OH \longrightarrow (NH_4)_2S + 2H_2O$$

In large industrial laboratories, a Kipp's generator is used for the continuous preparation of hydrogen sulfide.

26. Physical Properties.—Hydrogen sulfide is a colorless gas with a very offensive odor, like that of rotten eggs. The gas is extremely poisonous. If inhaled, it attacks the hemoglobin in a manner similar to that of carbon monoxide, producing death in a short time. Very dilute chlorine is recommended as an antidote. The gas is heavier than air and it is appreciably soluble in water. At 0° C., 4.67 volumes of the gas dissolve in 1 volume of water. The gas can be easily liquefied at 10° C. by subjecting it to 15 atmospheres of pressure. At normal atmospheric pressure, the liquid boils at $-61.8°$ C. and solidifies at $-82.9°$ C.

27. Chemical Properties.—Hydrogen sulfide burns in air, forming water and sulfur dioxide.

$$2H_2S + 3O_2 \longrightarrow 2H_2O + 2SO_2$$

Toward heat, hydrogen sulfide is very unstable, decomposing according to the following equation.

$$H_2S \longrightarrow H_2 + S$$

The decomposition begins to take place at 400° C., and at 500° C. it proceeds very rapidly.

All the metals down to and including silver in the activity series displace the hydrogen from hydrogen sulfide. For example,

$$2Cu + H_2S \longrightarrow Cu_2S + H_2$$

The tarnishing of silver is caused by the presence in the air of traces of hydrogen sulfide from coal fires, illuminating gas, and other sources.

$$2Ag + H_2S \longrightarrow Ag_2S + H_2$$

28. Tarnished silverware may be cleaned by a chemical process which is quicker than the use of silver polish and which does not remove any silver. The tarnished silver pieces are placed in an aluminum pan, each piece being in direct contact with the aluminum. The silverware is then covered with water, and one teaspoonful of common salt and one teaspoonful of baking soda are added for each quart of water used. The solution is then heated and allowed to boil for one or two minutes. If the silver pieces are then removed and dried, the result will be bright and clean silverware. The reaction that takes place is that some of the aluminum goes into solution as aluminum-ions, Al^{+++}, and, when these ions come in contact with the film of silver sulfide, they cause the sulfur to go into solution as sulfide-ions, $S^{=}$. Hence, the silver is freed from the sulfur.

29. Hydrosulfuric Acid.—Hydrosulfuric acid is a water solution of hydrogen sulfide gas. It is a very weak acid, having a very small degree of ionization, only .07 per cent.

$$H_2S \longrightarrow H^+ + HS^-$$

The dissociation of the hydrosulfide-ion, HS^-, into H^+ and $S^{=}$ ions is negligible, with the result that the amount of sulfide-ion, $S^{=}$, present is very negligible.

Hydrosulfuric acid is neutralized by bases.

$$H_2S + 2NaOH \longrightarrow Na_2S + 2H_2O$$

It enters into double decompositions with salts, forming insoluble sulfides.

$$H_2S + CuSO_4 \longrightarrow CuS + H_2SO_4$$

Hydrosulfuric acid is unstable and, upon standing, the oxygen of the air slowly displaces the sulfur, which appears as a fine white powder.

$$2H_2S + O_2 \longrightarrow 2H_2O + 2S$$

Hydrosulfuric acid is also a reducing agent, as its action upon iodine shows.

$$H_2S + I_2 \longrightarrow 2HI + S$$

30. Dibasic Acids.—Acids that have two ionizable hydrogen atoms in each molecule are called dibasic acids. Examples of such acids are H_2SO_4, H_2CO_3, and H_2S. Each molecule of a dibasic acid is able to react with two molecules of a base like sodium hydroxide. When one ionizable hydrogen atom is displaced, an acid salt is produced; when all of the hydrogen is displaced, a normal salt is produced. For example, the acid sulfide, or hydrosulfide, is produced by passing an excess of hydrogen sulfide into a solution of a soluble base, such as sodium hydroxide.

$$H_2S+NaOH \longrightarrow H_2O+NaHS$$

The normal salt is produced by adding, to the mentioned solution of acid sulfide, an amount of sodium hydroxide equal to the amount used before. Then, by evaporating the solution, the second unit of hydrogen is displaced by driving off the water, and the normal salt, or sodium sulfide, forms.

$$NaHS+NaOH \longrightarrow Na_2S+H_2O$$

31. Sulfides.—Sulfides are the salts of hydrosulfuric acid. All the salts formed when hydrosulfuric acid is neutralized by a base are called sulfides. Whenever a metal, such as zinc or copper, reacts with hydrosulfuric acid, the respective metallic sulfide results. A sulfide may also be prepared by the direct combination of an element with sulfur. For example,

$$Fe+S \longrightarrow FeS$$

Since hydrosulfuric acid is dibasic, it forms both the normal and the acid sulfide. The acid sulfide may be prepared by passing an excess of H_2S gas into a solution of a soluble base. Thus,

$$H_2S+NaOH \longrightarrow NaHS+H_2O$$

The normal sulfide may be prepared by adding to the foregoing solution of acid sulfide an amount of sodium hydroxide equal to that used before, and by evaporating to dryness. Thus,

$$NaHS+NaOH \longrightarrow Na_2S+H_2O$$

32. Classification of Sulfides.—Based on the difference in solubility, the sulfides are divided into three different groups. In analytical chemistry, advantage is taken of this classification, for the purpose of separating and identifying different metallic sulfides. The three classes are as follows:

Sulfides Insoluble in Dilute Acids.—The sulfides of silver, copper, mercury, and some other metals are practically insoluble in dilute acids. These sulfides may, therefore, be produced by passing hydrogen sulfide into solutions of their salts.

$$H_2S+2AgNO_3 \longrightarrow Ag_2S\downarrow +2HNO_3$$

Since the acid produced has very little effect upon the sulfide, no reverse action is noticed and the reaction practically goes to completion.

Sulfides Insoluble in Water but Soluble in Dilute Acids.—The sulfides of zinc, iron, and certain other metals are insoluble in water, but they are soluble in dilute acids. Hence, these sulfides cannot be precipitated by passing H_2S gas into their salt solutions because the dilute acid produced decomposes the sulfide and the reverse action is almost complete. These sulfides may be prepared by the direct union of the elements or by adding a soluble sulfide, such as ammonium sulfide, $(NH_4)_2S$, to a salt solution.

$$ZnSO_4+(NH_4)_2S \longrightarrow ZnS\downarrow +(NH_4)_2SO_4$$

Since no acid is produced in the foregoing reaction, the reaction practically goes to completion.

Soluble Sulfides.—The sulfides of calcium, barium, and many other metals are soluble in water and dilute acids. Since the sulfides of this group are soluble in water and dilute acids, they cannot be precipitated from their salt solution by passing H_2S gas through the solution or by the addition of a soluble sulfide. Hence, they are prepared by the direct combination of the elements or by the reduction of the sulfates by carbon. Thus,

$$Ca+S \longrightarrow CaS$$

$$BaSO_4+2C \longrightarrow BaS+2CO_2$$

SULFUR HALIDES

33. Introduction.—Many sulfur halides have been prepared and isolated and their properties investigated. The following sulfur halides are known to exist:

Sulfur monochloride, S_2Cl_2
Sulfur dichloride, SCl_2
Sulfur tetrachloride, SCl_4
Sulfur hexafluoride, SF_6
Sulfur monobromide, S_2Br_2

No sulfur compounds of iodine are known. The solid substance sold under the name of sulfur iodide is an ordinary mixture or at least a solid solution prepared by the evaporation of a mixed solution of iodine and sulfur in carbon disulfide.

34. Sulfur Monochloride.—Sulfur monochloride is prepared by passing dry chlorine gas into heated sulfur. It is the most stable of the sulfur chlorides. It is a yellowish-red liquid having a specific gravity of 1.68 and a boiling point of 135.6° C. Sulfur monochloride has a very pungent odor, fumes in moist air, and is decomposed by water. Its decomposition by water is shown by the following equation:

$$2S_2Cl_2+3H_2O \longrightarrow H_2SO_3+3S+4HCl$$

Sulfur monochloride is used extensively as a solvent for sulfur in the vulcanizing of rubber. It is also used to prepare certain anhydrous metallic chlorides.

35. Sulfur Dichloride and Tetrachloride.—Sulfur dichloride may be prepared by treating ice-cold sulfur monochloride with excess chlorine.

$$S_2Cl_2+Cl_2 \longrightarrow 2SCl_2$$

Sulfur dichloride is a dark-red liquid having a specific gravity of 1.62 and a boiling point of 59° C. When heated, it decomposes into sulfur monochloride and chlorine.

Sulfur tetrachloride is a yellowish-brown liquid that may be prepared by the prolonged action of excess chlorine on sulfur monochloride at −22° C. Sulfur tetrachloride exists only at temperatures below 0° C. When removed from the freezing mixture, it immediately begins to decompose, liberating chlorine and forming sulfur dichloride.

$$SCl_4 \longrightarrow SCl_2+Cl_2$$

36. Sulfur Hexafluoride and Monobromide.—Sulfur hexafluoride may be prepared by treating sulfur with fluorine. It is a colorless and odorless gas that is rather stable and chemically inactive. Its inactivity is shown by the fact that it is unaffected by water, whereas the other sulfur halides are all decomposed by water.

Sulfur monobromide may be prepared by dissolving sulfur in bromine or by heating sulfur with bromine. It is a red liquid. It has a specific gravity of 2.64 and resembles sulfur monochloride in chemical behavior.

SELENIUM

37. History and Occurrence.—Selenium was discovered by Berzelius (1817) in the slime that collected at the bottom of the lead chambers used in the manufacture of sulfuric acid. He gave it the name *selenium* (meaning moon) because of its chemical relation to the element tellurium (meaning earth), which was discovered a few years previously.

Although somewhat widely distributed, selenium occurs only in small quantities. It occurs free in some specimens of sulfur, and in combination it often takes the place of some of the sulfur in pyrites, FeS. Because of its presence in pyrites, it is found free in the dust flues of the pyrites-burners of sulfuric acid works. Many metallic selenides occur in small amounts in nature. The principal source of selenium, at the present time, is the anode slime formed in the electrolytic refining of copper.

38. Preparation.—Selenium is prepared mainly from the anode slime formed in the electrolytic refining of copper. The slime is roasted in air which causes the selenium to combine with oxygen to form selenium oxide. The roasting also causes the selenium oxide to volatilize, which in turn is dissolved by hydrochloric acid. The selenium oxide is then reduced by sulfur dioxide, and free selenium is precipitated.

39. After roasting, some selenium remains unoxidized. This is recovered by heating the residue with sodium hydroxide and sodium nitrate, whereby sodium selenite is formed. The sodium selenite formed is extracted with water, and the solution is then acidified.

$$Na_2SeO_3 \cdot 5H_2O + 2HCl \longrightarrow 2NaCl + H_2SeO_3 + 5H_2O$$

The acidified solution is then treated with sulfur dioxide. The selenious acid is reduced by the sulfur dioxide and the selenium is precipitated as before.

$$H_2SeO_3+H_2O+2SO_2 \longrightarrow 2H_2SO_4+Se\downarrow$$

Selenium is also prepared, to some extent, from the slime and flue dust found in sulfuric acid works.

40. Properties of Selenium.—Selenium, like sulfur, occurs in several allotropic forms. Its modifications fall in three groups: crystalline, metallic, and amorphous.

There are two crystalline varieties of selenium. They form red monoclinic crystals, have a specific gravity of about 4.7, and their melting points are between 170° C. and 180° C. Both forms are soluble in carbon disulfide.

The metallic selenium is formed when it is heated between 200° C. and 230° C. for some time. It has a steel-gray color, a specific gravity of about 4.8, and it is insoluble in carbon disulfide. The metallic variety is the most stable form of selenium.

The amorphous variety is formed by suddenly cooling molten selenium. It is a red vitreous form. It has a specific gravity of 4.28, and is a poor conductor of both heat and electricity.

41. All varieties of selenium boil at 688° C., forming a dark-red vapor. The density of the vapor diminishes as the temperature increases. The molecular formula of dissolved selenium is Se_8. However, at 1400° C. the vapor density corresponds to the formula Se_2, and at 2000° C. the vapor density corresponds to the monatomic formula Se.

The reactions of selenium are similar to those of sulfur. However, it is a poorer reducing and oxidizing agent than sulfur. It combines directly with many metals to form selenides, burns in oxygen to form selenium dioxide, and unites vigorously with chlorine.

42. Hydrogen Selenide.—Hydrogen selenide, H_2Se, may be prepared by heating hydrogen and selenium in a closed vessel.

$$H_2+Se \longrightarrow H_2Se$$

A more practical method of preparation is by treating a metallic selenide, such as ferrous selenide, with a dilute acid.

$$FeSe+2HCl \longrightarrow FeCl_2+H_2Se\uparrow$$

Hydrogen selenide is a colorless gas having a very offensive odor. *It is inflammable and very poisonous.* It resembles hydrogen sulfide, but it is more poisonous and less stable. It is soluble in water, forming a very feeble acid. Its acid solution is very readily oxidized on exposure to the air, with the precipitation of red selenium. It burns in air, forming selenium dioxide and water. The acition of hydrogen selenide in precipitating many metallic selenides is similar to that of hydrogen sulfide. *Selenides are all toxic.* Hence, care must be taken in handling the element.

43. Halogen Compounds of Selenium.—Selenium combines with the halogens to form various halides, but no compounds of selenium and iodine are known. Of the various selenium halides, two chlorides are known, namely, selenium monochloride, Se_2Cl_2, and selenium tetrachloride, $SeCl_4$. They are formed by the direct union of the elements. The tetrachloride is formed by heating the monochloride.

$$2Se_2Cl_2 \xrightarrow{\Delta} SeCl_4 + 3Se$$

Selenium oxychloride, $SeOCl_2$, is an important compound. It is a liquid formed by the partial hydrolysis of selenium tetrachloride.

$$SeCl_4 + H_2O \longrightarrow SeOCl_2 + 2HCl$$

It is a highly corrosive and active liquid that has unusual solvent properties.

44. Industrial Applications.—In addition to the uses already mentioned, selenium has other important applications. Its largest consumption is in the manufacture of ruby-red glass and red pigments for iron enamels, and in the glass industry for the removal of the green tinge of the glass caused by ferrous iron. Increasing amounts of selenium are also being used in place of sulfur in the vulcanization of certain types of rubber and in the preparation of pigments and paints. A small amount of selenium is added to copper alloys and stainless steel to make them more machinable.

TELLURIUM

45. History and Occurrence.—Tellurium was discovered in 1782 by Muller von Reichenstein. In 1798, Klaproth named it from the Latin word *tellus*, meaning earth, and in 1832 Berzelius discovered its likeness to sulfur and selenium.

Tellurium, like selenium, although it is widely distributed, is not a plentiful element. Small amounts of tellurium are found in the free state, but the largest amounts are usually found combined with gold, silver, lead, and bismuth as tellurides. However, like selenium, its principal source is the anode slime obtained in the electrolytic refining of copper.

46. Preparation.—Pure tellurium is prepared from the anode slime after the slime is roasted and the selenium oxide is volatilized, as explained in Art. 38. The residue is then heated with sodium hydroxide and sodium nitrate, so that sodium telluride and sodium selenide are formed. These substances are extracted with water and are separated by acidifying the solution, tellurium dioxide precipitating out of solution. The precipitate, TeO, is removed from the solution and is reduced to the free element by roasting with coal or charcoal.

$$2TeO+C \longrightarrow 2Te+CO_2 \uparrow$$

47. Tellurium can also be prepared from tetradymite, Bi_2Te_3. The bismuth telluride is first fused with sodium carbonate.

$$Bi_2Te_3+3Na_2CO_3 \longrightarrow Bi_2O_3+3CO_2+3Na_2Te$$

Then the sodium telluride, Na_2Te, formed is extracted with water. Finally, the sodium telluride is oxidized by passing air through its aqueous solution and free tellurium is obtained.

$$2Na_2Te+2H_2O+O_2 \longrightarrow 4NaOH+2Te$$

48. Properties of Tellurium.—Although tellurium, like sulfur and selenium, occurs in several forms, its degree of allotropism is less marked. It occurs in both a crystalline and an amorphous variety. The crystalline form is the more stable, has a silvery-gray color and a metallic luster, and has a specific gravity of 6.

The amorphous form has a specific gravity of about 6. Tellurium is a good conductor of electricity. It melts at 452° C. and boils at 1390° C., giving off a golden-yellow vapor. At 1500° C. its vapor density corresponds to the molecular formula of Te_2, but at 2000° C. the gas is monatomic.

The chemical properties of tellurium are similar to those of sulfur and selenium. The hydride, however, is even more unstable than hydrogen selenide and the dioxide is amphoteric. An amphoteric substance is a substance that possesses both acidic and basic properties. The free element combines directly with most metals, burns in air to form the dioxide, and is vigorously attacked by chlorine.

49. Hydrogen Telluride.—Hydrogen telluride, H_2Te, may be prepared by treating zinc or magnesium telluride with dilute hydrochloric acid.

$$ZnTe + 2HCl \longrightarrow ZnCl_2 + H_2Te$$

Hydrogen telluride is a colorless and combustible gas having a very offensive odor. Its chemical properties are similar to those of hydrogen sulfide and hydrogen selenide. However, it is the most unstable of the three, decomposing at ordinary temperatures on exposure to light. Hydrogen telluride is soluble in water, and its aqueous solution will precipitate the tellurides of certain metals from their solutions.

50. Industrial Applications.—Very few uses have been developed for tellurium and its compounds, although many have been sought in recent years. Tellurium is added to lead to improve its tensile strength and to increase the resistance of the metal to corrosion or chemical attack. A solution of tellurium dioxide in concentrated hydrochloric acid is used on metallic stamps, such as those on the base of automobile light bulbs. It is also used in the electroplating of silver for the production of a dark finish.

OXYGEN COMPOUNDS OF SULFUR FAMILY

51. Oxides and Oxygen Acids of Sulfur.—The following are the names and formulas of the oxides and oxygen acids of sulfur:

OXIDES		ACIDS
Sulfur dioxide, SO_2	$\rightleftarrows$	Sulfurous acid, H_2SO_3
Sulfur trioxide, SO_3	$\rightleftarrows$	Sulfuric acid, H_2SO_4

Salts of these acids are known. When the acids are dehydrated, they produce the anhydrides indicated by the arrows. Conversely, when the oxides combine with water, they produce the acids indicated by the arrows. In addition to sulfur dioxide and sulfur trioxide, other oxides of sulfur have been prepared. They are as follows:

Sulfur monoxide, SO
Sulfur sesquioxide, S_2O_3
Sulfur heptoxide, S_2O_7
Sulfur tetroxide, SO_4

These oxides are not of any great importance, hence, they will receive no further elaboration.

52. Sulfur Dioxide.—Sulfur dioxide, or sulfurous anhydride, SO_2, may be prepared in the laboratory by treating sodium sulfite or bisulfite with concentrated hydrochloric or concentrated sulfuric acid. For example,

$$Na_2SO_3 + 2HCl \longrightarrow 2NaCl + H_2O + SO_2 \uparrow$$

For laboratory purposes, the gas is also conveniently prepared by treating concentrated sulfuric acid with a suitable reducing agent, such as copper or mercury. The reaction of sulfuric acid and copper is usually represented by the following equation:

$$Cu + 2H_2SO_4 \longrightarrow CuSO_4 + 2H_2O + SO_2$$

53. The foregoing reaction is more complex than is shown by the equation. It is possible that two different intermediate reactions take place before the final reaction. The first possible reaction is that the copper is first oxidized and the sulfuric acid is reduced to sulfur dioxide and the copper oxide formed interacts with more sulfuric acid to produce the copper sulfate salt and water. The two consecutive reactions are as follows:

$$Cu + H_2SO_4 \longrightarrow CuO + H_2O + SO_2$$
$$CuO + H_2SO_4 \longrightarrow CuSO_4 + H_2O$$

The alternative intermediate reaction is that hydrogen is first liberated by the metal, and that the excess sulfuric acid oxidizes the hydrogen as soon as it is produced. These consecutive reactions are represented as follows:

$$Cu + H_2SO_4 \longrightarrow CuSO_4 + H_2$$
$$H_2 + H_2SO_4 \longrightarrow 2H_2O + SO_2$$

In either case, the final reaction is that sulfur dioxide is produced and copper sulfate and water are formed.

54. Industrial Preparation of Sulfur Dioxide.—For industrial purposes, sulfur dioxide is usually prepared by one of the following methods:

1. By burning sulfur in air.

$$S + O_2 \longrightarrow SO_2$$

When burned in air, 6 to 8 per cent of the sulfur is oxidized to sulfur trioxide; when burned in pure oxygen, only 2 to 3 per cent of the sulfur is oxidized to sulfur trioxide. These facts indicate that nitrogen seems to favor the production of sulfur trioxide.

2. By roasting the sulfides of metals, such as iron or copper pyrites.

$$4FeS_2 + 11O_2 \longrightarrow 2Fe_2O_3 + 8SO_2$$

This is the reaction commonly used for making the sulfur dioxide used in the manufacture of sulfuric acid. The sulfur dioxide produced from iron pyrites by this method contains arsenic as an impurity; because it is injurious for many purposes, the arsenic must be removed. Roasting, or calcining, is the forced combustion of an ore, such as the foregoing reaction, and is the first step in obtaining the free metal. The free metal is obtained by reducing the oxide by heating it with coke.

55. Physical Properties of Sulfur Dioxide.—Sulfur dioxide is a colorless gas, having a very pungent and suffocating odor. The gas, which is more than twice as heavy as air, has a specific gravity of 2.264. *Sulfur dioxide is a blood poison and is also injurious to vegetation.* Sulfur dioxide is very soluble in water. At 0° C., 80 volumes of sulfur dioxide dissolve in 1 volume of water.

Sulfur dioxide can be easily liquefied to a colorless, limpid liquid that boils at $-10°$ C. Hence, the gas can be liquefied under atmospheric pressure by merely cooling it to $-10°$ C. or lower. Liquid sulfur dioxide solidifies at $-72.7°$ C. to form a snowlike mass. When liquid sulfur dioxide is evaporated, a temperature of about $-50°$ C. can be obtained; because of this fact, sulfur dioxide, like ammonia, is used as a refrigerant.

56. Chemical Properties of Sulfur Dioxide.—Sulfur dioxide is a stable compound, decomposing only at high temperatures. When heated, sulfur dioxide combines with oxygen to form sulfur trioxide.

$$2SO_2+O_2 \rightleftarrows 2SO_3$$

This reaction is slow and reversible; but in the presence of a catalyst, such as platinum, the reaction proceeds almost to completion.

Sulfur dioxide combines directly with fluorine, chlorine, and bromine to form the respective sulfuryl halides, particularly in the presence of camphor, which acts as a catalyst. Thus,

$$SO_2+F_2 \longrightarrow SO_2F_2$$
$$SO_2+Cl_2 \longrightarrow SO_2Cl_2$$
$$SO_2+Br_2 \longrightarrow SO_2Br_2$$

Sulfur dioxide also reacts with water to form sulfurous acid, H_2SO_3, which is unstable and exists only in solution.

57. Uses of Sulfur Dioxide.—Sulfur dioxide is used extensively in the manufacture of sulfuric acid and of sulfites. Liquid sulfur dioxide is used as an insecticide and as a solvent for substances such as iodine, phosphorus, sulfur, and certain inorganic salts. Large quantities of liquid sulfur dioxide are used in the manufacture of sugar and in the bleaching of straw, wool, silk, and materials too delicate for chlorine.

58. Sulfurous Acid.—Sulfurous acid, H_2SO_3, may be easily prepared by dissolving sulfur dioxide in water. The acid is very unstable and has never been isolated. Nevertheless, the presence of the acid in a water solution is shown by the fact that the solution behaves as an acid, that is, it turns blue litmus red and reacts with metals to form sulfites.

Sulfurous acid is easily oxidized. It combines with the oxygen of the air to form sulfuric acid.

$$2H_2SO_3+O_2 \longrightarrow 2H_2SO_4$$

Because sulfurous acid is easily oxidized to sulfuric acid, it is a powerful reducing agent. It reduces the permanganates to the manganous salts and the ferric to the ferrous salts.

59. Uses of Sulfurous Acid.—Sulfurous acid is a good bleaching agent, and is extensively used for this purpose where delicate fabrics would be destroyed by the stronger action of bleaching powder. It is used in the bleaching and preserving of fruit. Dried apples and peaches are prepared by exposing slices of the fruit to sulfur dioxide. The sulfur dioxide combines with the water of the fruit, and the sulfurous acid formed bleaches the fruit and keeps insects away during the subsequent drying. It is also used to prepare calcium bisulfite, $Ca(HSO_3)_2$, which is used in the manufacture of paper.

$$2H_2SO_3+CaCO_3 \longrightarrow Ca(HSO_3)_2+H_2O+CO_2 \uparrow$$

The solution of calcium bisulfite dissolves the lignin out of the wood, and leaves the pure cellulose (paper pulp) unaffected.

60. Sulfites.—Sulfites are the salts of sulfurous acid. Since sulfurous acid is dibasic, two series of sulfites are known. They are the normal sulfites, such as Na_2SO_3, and the acid salts, or bisulfites, such as $NaHSO_3$. The acid sulfite may be prepared by adding an excess of sulfurous acid to a base and evaporating.

$$NaOH+H_2SO_3 \longrightarrow NaHSO_3+H_2O \uparrow$$

The normal sulfite is prepared by complete neutralization of the acid by a base and evaporation.

$$2NaOH + H_2SO_3 \longrightarrow Na_2SO_3 + 2H_2O \uparrow$$

Both series of sulfites are decomposed by heat and the corresponding stable sulfate is formed.

$$4Na_2SO_3 \longrightarrow 3Na_2SO_4 + Na_2S$$

The bisulfite, when heated, first decomposes as follows:

$$2NaHSO_3 \longrightarrow Na_2SO_3 + H_2O + SO_2$$

The normal sulfite formed then decomposes as previously explained.

The sulfites are readily oxidized, as is sulfurous acid. Both in the solid form and in solution, the sulfites are easily oxidized by the oxygen of the air to the stable sulfate. Thus,

$$2Na_2SO_3 + O_2 \longrightarrow 2Na_2SO_4$$

Because they are easily oxidized to the corresponding sulfates, the sulfites are used as powerful reducing agents.

61. Sulfur Trioxide.—Sulfur trioxide, or sulfuric anhydride, SO_3, is used in the manufacture of sulfuric acid by the contact process. Sulfur trioxide may be prepared by the dry distillation of ferric sulfate or by treating dehydrated concentrated sulfuric acid with phosphorus pentoxide. Thus,

$$Fe_2(SO_4)_3 \longrightarrow Fe_2O_3 + 3SO_3$$
$$H_2SO_4 + P_2O_5 \longrightarrow 2HPO_3 + SO_3$$

Sulfur trioxide can also be prepared by heating sulfur dioxide and oxygen to about 400° C.

$$2SO_2 + O_2 \rightleftarrows 2SO_3 + 45{,}200 \text{ calories}$$

In this reaction, however, very little sulfur trioxide is produced and much heat is evolved. Nevertheless, under special conditions this reaction can be utilized for the industrial production of sulfur trioxide. An increase in temperature cannot be utilized in the foregoing reaction, since by applying van't Hoff's law it can be seen that an increase in temperature will favor the reverse action. However, by using a catalyst such as platinum, the reaction proceeds quickly and almost to completion, and at 400° C. a yield of about 99 per cent of sulfur trioxide is obtained.

62. Physical Properties of Sulfur Trioxide.—Sulfur trioxide is a white crystalline solid that exists in two allotropic forms, known as the alpha and the beta forms. The alpha form melts at 16.8° C., so that at ordinary conditions it is a colorless liquid having a specific gravity of 1.923. The liquid boils at 44.6° C. It is very volatile at room temperature, and it fumes strongly when exposed to the air. The fumes are caused by the combination of the sulfur trioxide vapor with the moisture in the air to form droplets of sulfuric acid.

The beta form is a white crystalline solid that resembles asbestos. Its formula is $(SO_3)_2$ and it is the more stable form. It melts at 32.2° C. and boils at 44.6° C.

63. Chemical Properties of Sulfur Trioxide.—Both varieties of sulfur trioxide behave the same chemically. Sulfur trioxide combines very vigorously with water to produce sulfuric acid, much heat being evolved.

$$SO_3 + H_2O \longrightarrow H_2SO_4$$

Sulfur trioxide combines vigorously with many metallic oxides, producing the corresponding sulfates. For example,

$$MgO + SO_3 \longrightarrow MgSO_4$$
$$CaO + SO_3 \longrightarrow CaSO_4$$

In the formation of the foregoing metallic sulfates, so much heat is evolved that the mass becomes incandescent.

Sulfur trioxide also combines with sulfuric acid to produce fuming sulfuric acid, or oleum.

$$H_2SO_4 + SO_3 \longrightarrow H_2S_2O_7$$

64. Sulfuric Acid.—Sulfuric acid is the most important compound of sulfur and is a substance that is essential in most chemical industries. It is used extensively in the manufacture of other chemicals, such as hydrochloric acid, nitric acid, and sodium carbonate. Large quantities are also used in the manufacture of fertilizers, explosives, and organic dyes. Two methods

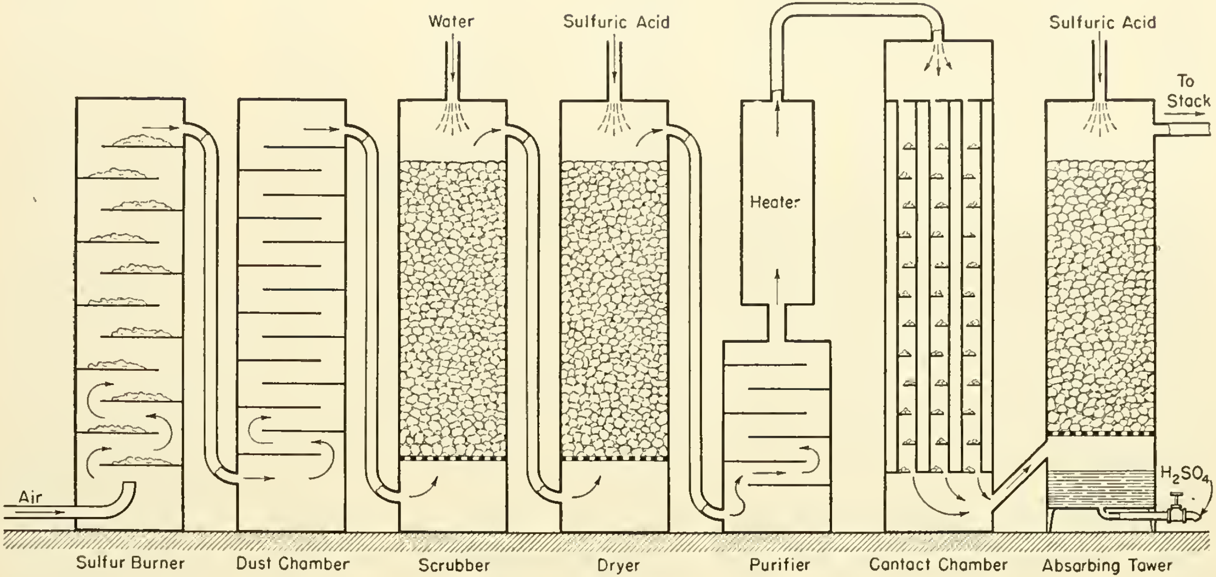

Water
Sulfuric Acid
Sulfuric Acid
To Stack
Heater
H_2SO_4
Air
Sulfur Burner
Dust Chamber
Scrubber
Dryer
Purifier
Contact Chamber
Absorbing Tower

FIG. 8

are used for the manufacture of sulfuric acid. The two methods used are "the contact process" and "the lead-chamber process."

65. Contact Process.—In the contact process the following reactions are involved:

1. The formation of sulfur dioxide by burning free sulfur or a sulfide.

$$S+O_2 \longrightarrow SO_2$$

2. The oxidation of sulfur dioxide to sulfur trioxide.

$$2SO_2+O_2 \longrightarrow 2SO_3$$

3. The absorption of sulfur trioxide.

$$SO_3+H_2SO_4 \longrightarrow H_2S_2O_7$$

4. The dilution of the fuming sulfuric acid.

$$H_2S_2O_7+H_2O \longrightarrow 2H_2SO_4$$

66. In the contact process, it is absolutely necessary that all the impurities from sulfur dioxide be removed, such as dust and arsenic derived from the roasting of pyrites or some other mineral sulfide. The most minute quantities of these substances poison the catalyst used in the oxidation of sulfur dioxide to sulfur trioxide. The impurities are removed by passing the sulfur dioxide gas produced in the burner, Fig. 8, into the dust chamber. The gas is then passed through the scrubber, which is filled with crushed quartz over which water flows. The scrubbed gas is then dried by passing it through the dryer, which is also filled with crushed quartz and over which concentrated sulfuric acid flows. The sulfuric acid absorbs the water and the sulfur dioxide passes on through the purifier, where the arsenic is removed.

67. Free from impurities, the sulfur dioxide is first heated to the proper temperature in the heater, Fig. 8, and is then admitted to the contact chamber. In the contact chamber, under proper conditions and in the presence of a suitable catalyst, the sulfur dioxide is oxidized by the oxygen of the air to sulfur trioxide. The oxidation of sulfur dioxide by oxygen is hastened by many substances, such as glass, ferric oxide,

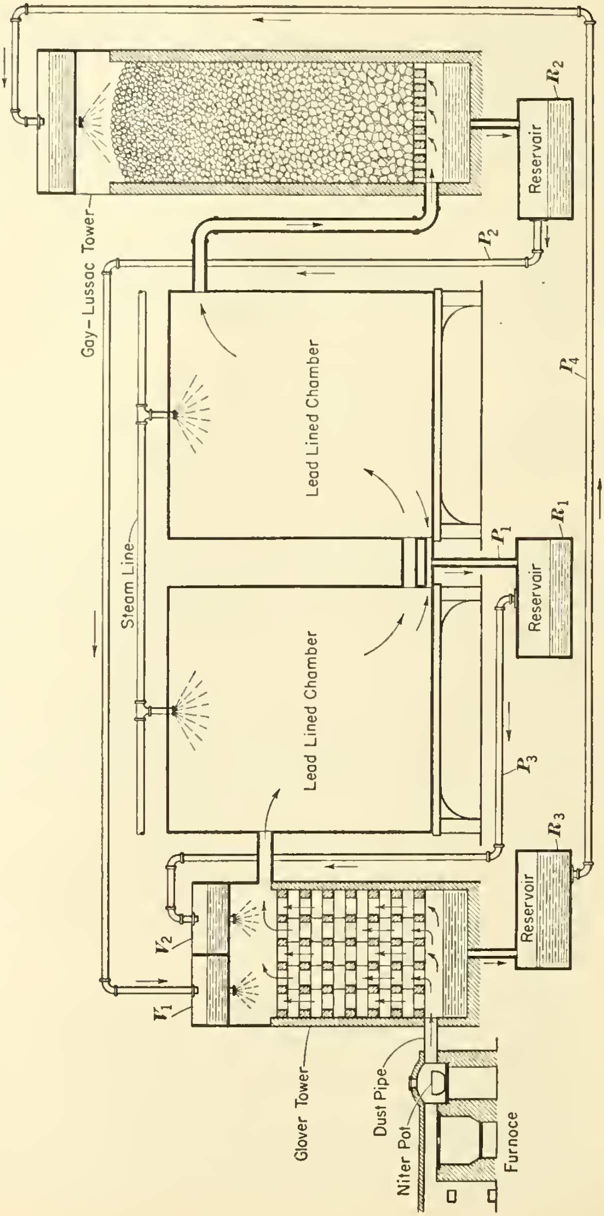

Gay-Lussac Tower
Reservoir
R_2
P_2
Lead Lined Chamber
Steam Line
P_1
R_1
Reservoir
P_4
Lead Lined Chamber
P_3
R_3
Reservoir
V_2
V_1
Glover Tower
Dust Pipe
Niter Pot
Furnace

Fig. 9

porcelain, and finely divided platinum. These substances remain unchanged, acting simply as contact, or catalytic, agents. The catalyst that has been commonly used in the contact process is platinum, dispersed in a finely divided form throughout a suitable supporting material, or base. Magnesium sulfate and silica gel are substances that are used as a base. Vanadium pentoxide, a substance that is very resistant to poisoning and comparatively inexpensive, is rapidly replacing platinum as a catalyst.

68. A fairly constant temperature, ranging from 400° C. to 450° C., is maintained in the contact chamber throughout the oxidation of sulfur dioxide. The need for a constant temperature can be seen by examining the following thermochemical equation:

$$2SO_2 + O_2 \longrightarrow 2SO_3 + 45{,}200 \text{ calories}$$

Since the system has a tendency to get hotter, due to the heat evolved, and hence, lead to a decrease in the yield of sulfur trioxide, the heat produced must be checked. The temperature is kept constant by leading the cold entering air over the outside of the pipes that contain the catalyst.

69. The sulfur trioxide vapor, SO_3, mixed with excess O_2 and inert N_2 is finally led into the absorbing tower. In the tower, the SO_3 is absorbed by 97–99 per cent sulfuric acid, and the O_2 and N_2 leave the absorbing tower by passing through the stack. Neither water nor dilute sulfuric acid are good absorbing agents for SO_3, in which case the formation of a "mist" of sulfuric acid droplets prevents any further absorption of the SO_3 vapor. However, when the vapor is passed into 97–99 per cent sulfuric acid, no mist is formed and the SO_3 is readily absorbed. A constant concentration of the acid is maintained by a regular influx of water or dilute acid. If pyrosulfuric, or fuming sulfuric, acid, $H_2S_2O_7$, is desired, the addition of water is omitted. The contact process, as described, is the best method for the preparation of a highly concentrated sulfuric acid.

70. Lead-Chamber Process.—The name of the lead-chamber process is derived from the fact that the main reactions are carried out in large lead chambers. The process consists essentially in bringing together, in the presence of the oxides of nitrogen and under suitable conditions, sulfur dioxide, oxygen, and water to form sulfuric acid. The principle involved in this process, which is the oxidation of sulfur dioxide, is similar to that of the contact process. Whereas in the contact process oxidation is accomplished with air in the presence of a contact catalyst, in the lead-chamber process the oxidation is accomplished with air in the presence of the oxides of nitrogen.

71. The process is carried out in what is called a lead-chamber plant, Fig. 9. The main features of the plant are a furnace for the production of sulfur dioxide, a niter pot for supplying the needed nitrogen oxides, lead chambers in which the main reactions take place, the Gay-Lussac tower necessary for the recovery of the oxides of nitrogen, and the Glover tower necessary for the reintroduction of the oxides of nitrogen into the reaction stream.

72. In the practical operation of the process, the sulfur dioxide is produced by burning sulfur or by roasting sulfides, such as iron pyrites, FeS_2, in the furnace, Fig. 9.

$$4FeS_2 + 11O_2 \longrightarrow 2Fe_2O_3 + 8SO_2$$

The air supply is adjusted so that an excess of oxygen, which is needed for later changes, is present in the gases leaving the furnace. The oxides of nitrogen are obtained from the nitric acid, which is produced by the action of sulfuric acid on sodium nitrate in the niter pot.

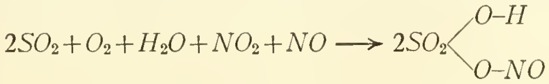
$$H_2SO_4 + NaNO_3 \longrightarrow NaHSO_4 + HNO_3 \uparrow$$

Because of its volatility, the nitric acid vaporizes and the vapor is swept along with the other gases into the Glover tower, where it is immediately reduced into its oxides by the sulfur dioxide.

$$H_2O + 2SO_2 + 2HNO_3 \longrightarrow 2H_2SO_4 + NO_2 + NO$$

73. The mixture of sulfur dioxide and air is passed through a long flue, in which any dust carried over from the furnace is deposited. The purified mixture of gases is then led to the

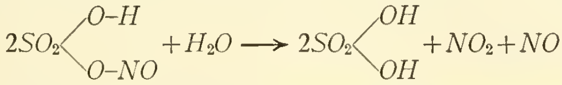
Glover tower, Fig. 9, where it mixes with the oxides of nitrogen to form the complex compound known as nitrosylsulfuric acid.



$$2SO_2+O_2+H_2O+NO_2+NO \longrightarrow 2SO_2\begin{cases} O-H \\ O-NO \end{cases}$$

The $-NO$ group is called the nitrosyl group and, if in this compound it is replaced by hydrogen, sulfuric acid will result; therefore, the compound is called nitrosylsulfuric acid.

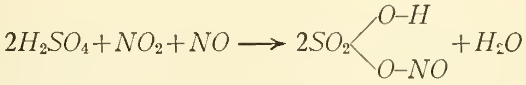
74. The nitrosylsulfuric acid vapor leaves the Glover tower, Fig. 9, and passes into the lead chambers, where an excess of water vapor is present. The excess water decomposes the nitrosylsulfuric acid into sulfuric acid and the oxides of nitrogen



$$2SO_2\begin{cases} O-H \\ O-NO \end{cases} + H_2O \longrightarrow 2SO_2\begin{cases} OH \\ OH \end{cases} + NO_2+NO$$

The sulfuric acid formed in the lead chambers is known as chamber acid. The acid, which is very dilute because of the excess water, collects on the floor and is led by the pipe P_1 into the reservoir R_1, and the oxides of nitrogen pass on into the Gay-Lussac tower.

75. In the Gay-Lussac tower, Fig. 9, the oxides of nitrogen are absorbed by concentrated sulfuric acid, which trickles down over the tiles with which the tower is packed. The object of this tower is to catch the oxides of nitrogen so that they may be reemployed in the reaction stream. The object is accomplished by a reversal of the lead-chamber reaction. Thus,



$$2H_2SO_4+NO_2+NO \longrightarrow 2SO_2\begin{cases} O-H \\ O-NO \end{cases} + H_2O$$

The nitrosylsulfuric acid formed is collected in a reservoir R_2, from which it is pumped through a pipe P_2 to a vessel V_1 at the top of the Glover tower. Dilute sulfuric acid is also pumped to a neighboring vessel V_2 at the top of the Glover tower from the reservoir R_1, by means of a pipe P_3.

76. When the nitrosylsulfuric acid and the dilute sulfuric acid flow down through the Glover tower, Fig. 9, the oxides of nitrogen are again set free by the action of the water on the dilute sulfuric acid, and a rather concentrated sulfuric acid is formed. The concentrated sulfuric acid, after passing through the tower, is collected in a reservoir R_3, from where as much acid as is needed is pumped through a pipe P_4 to the top of the Gay-Lussac tower to be used again for the absorption of the oxides of nitrogen. At the same time, the hot gases (SO_2 and O_2) ascending the tower mix with the liberated oxides of nitrogen and pass on to the lead chambers. The gases entering the chambers are mixed with water vapor and the reactions of the chambers are repeated so that there is a continual formation of the sulfuric acid. This process is continuous, but due to mechanical imperfections some of the oxides of nitrogen are lost; hence, in practice there must be a continual replacement of these oxides.

77. Most of the sulfuric acid obtained in this process is the dilute acid, containing from 60 to 70 per cent sulfuric acid, formed in the lead chambers. Although this dilute acid is used directly in some industrial processes, such as the manufacture of superphosphates used as fertilizers, a more concentrated acid is required for many other purposes. Some of the chamber acid is concentrated by utilizing the waste heat of the pyrites burners. The acid is heated in flat lead pans, and the evaporation is carried on until an acid having a concentration of 77 per cent is obtained. The concentration of the acid, up to this point, can be carried on in the lead pans because the crust of lead sulfate formed by the action of sulfuric acid on the lead protects the lead from further attack; but beyond this concentration the acid dissolves the crust and rapidly corrodes the lead. For concentrations beyond 77 per cent sulfuric acid, the dilute acid is heated in silica or cast-iron evaporators.

78. Physical Properties of Sulfuric Acid.—Pure hydrogen sulfate (100 per cent sulfuric acid) is a heavy, colorless liquid. It has a specific gravity of 1.84 and freezes into beautiful crystals that melt at 10.4° C. Pure sulfuric acid is relatively non-volatile. It decomposes at a temperature of 160° to 180° C., which is much below its boiling point, into sulfur trioxide and water. It begins to boil at 270° C., giving off more SO_3 than water, and finally an acid with a constant boiling point (338° C.) and constant composition (98.33 per cent sulfuric acid) is obtained. The acid is extremely corrosive and if spilled on the skin produces severe burns.

79. Chemical Properties of Hydrogen Sulfate.—Pure hydrogen sulfate, or 100 per cent sulfuric acid, has chemical properties that are different from those of dilute sulfuric acid. It is rather unstable, dissociating into sulfur trioxide and water.

$$H_2SO_4 \longrightarrow SO_3 + H_2O$$

When heated to 420° C., the dissociation of the vapor is complete. If the acid is suddenly heated to a bright-red heat, it decomposes completely into sulfur dioxide, water, and oxygen.

Pure hydrogen sulfate combines with sulfur trioxide to form pyrosulfuric acid.

$$H_2SO_4 + SO_3 \longrightarrow H_2S_2O_7$$

Hydrogen sulfate combines very vigorously with water to form several hydrates, of which the most important is the monohydrate, $H_2SO_4 \cdot H_2O$. Because of its affinity for water, hydrogen sulfate is a very good drying agent.

Highly concentrated sulfuric acid abstracts the elements of water from many organic compounds, particularly those containing hydrogen and oxygen in the same proportions in which they exist in water. For example, its action on sugar is shown by the following equation:

$$C_{12}H_{22}O_{11} \xrightarrow{H_2SO_4} 12C + 11H_2O$$

The sugar first turns pale brown, rapidly darkens, and finally becomes black; at the same time, the mass swells considerably and much steam is evolved.

Hot concentrated sulfuric acid is a very good oxidizing agent. This is due to its large quantity of oxygen and to its instability when heated. Its oxidizing action on copper has been discussed in Art. 53.

80. Chemical Properties of Dilute Sulfuric Acid.—Concentrated sulfuric acid, or hydrogen sulfate, dissolves in water with the evolution of much heat. The dilution of the concentrated acid may be safely performed by pouring the acid into the water, in which it sinks because of its greater density. Constant stirring during the addition of the acid to the water prevents local heating. Water should never be added to the concentrated acid because, since it is lighter than the acid, it floats on the surface of the acid and the heat of the reaction between the two liquids produces enough steam to cause a dangerous spattering of the acid.

Dilute sulfuric acid reacts with all metals except copper, mercury, and the noble metals, producing hydrogen and the respective metallic sulfate. For example,

$$Zn + H_2SO_4 \longrightarrow ZnSO_4 + H_2$$
$$2Fe + 3H_2SO_4 \longrightarrow Fe_2(SO_4)_3 + 3H_2$$

Dilute sulfuric acid enters into double decomposition reactions with bases and salts.

$$H_2SO_4 + 2NaOH \longrightarrow Na_2SO_4 + 2H_2O$$
$$H_2SO_4 + BaCl_2 \longrightarrow BaSO_4 \downarrow + 2HCl$$

The barium chloride, $BaCl_2$, reaction is used as a test for soluble sulfates. When barium chloride is added to any soluble sulfate, the white precipitate of barium sulfate, $BaSO_4$, will form.

81. Reaction of Acids.—Now that the important acids have been discussed and skill in writing chemical reactions has been acquired, it is well to review and consider the reactions of acids in general. When acids react with other substances they lose their acid properties, such as sour taste and ability to redden litmus. In such a reaction, the acid is said to be neutralized by the other substance. The following are examples of some of the substances that will react with and neutralize acids:

Metallic hydroxides react with acids to form a salt and water.

$$KOH + H_2SO_4 \longrightarrow KHSO_4 + H_2O \text{ (first stage)}$$
$$KOH + KHSO_4 \longrightarrow K_2SO_4 + H_2O \text{ (second stage)}$$

Since sulfuric acid is diabasic, this reaction takes place in two consecutive reactions.

Metallic oxides react with acids to form a salt and water.

$$CaO + 2HCl \longrightarrow CaCl_2 + H_2O$$

Metallic sulfides react with acids to form a salt and liberate hydrogen sulfide gas.

$$Na_2S + 2HCl \longrightarrow 2NaCl + H_2S \uparrow$$

Carbonates react with acids to form a salt and liberate carbon dioxide.

$$CaCO_3 + H_2SO_4 \longrightarrow CaSO_4 + H_2CO_3$$
$$\hookrightarrow H_2O + CO_2 \uparrow$$

This type of reaction is used to represent the formation of carbonic acid, which immediately decomposes and liberates the carbon dioxide gas.

The active metals react with acids to form a salt and liberate hydrogen.

$$Zn + H_2SO_4 \longrightarrow ZnSO_4 + H_2 \uparrow$$

In the foregoing reactions, a solution containing a dissolved salt is formed by the apparent replacement of part or all of the hydrogen of the acid by the metal. In most cases, the salt can be obtained in crystalline structure by evaporation of the solution.

82. Reactions of Acids With Water.—That a reaction actually takes place when an acid is dissolved in water is shown by the considerable amount of heat that is liberated when concentrated sulfuric or nitric acid is diluted with water. The dilution of an acid also causes an important change in its properties. For instance, the pure 100 per cent acids, such as sulfuric and nitric acids, are very poor conductors of electricity, whereas the dilute acids are excellent conductors.

The conductance of the electric current by the dilute acids suggests that the solution formed by dissolving the acid in water contains ions. When a current of electricity is passed through a dilute acid, the ions, which are electrically charged atoms or groups of atoms, move through the solution and carry the electric charges with them. Hence, the electricity is conducted through the solution from one electrode to another, as separate small charges, by individual ions. Ions having opposite charges move through the solution in opposite directions. This explanation accounts for the fact that dilute acids are good conductors of electricity.

83. The dilution of concentrated sulfuric acid illustrates the foregoing explanation. The heat liberated indicates a chemical reaction, and the fact that the solution is a good conductor of electricity indicates that ions are present in the solution. Furthermore, the fact that the solution continues to liberate hydrogen at the cathode, during the electrolysis of dilute sulfuric acid, indicates that the hydrogen-ions migrate toward the cathode, no matter where they may be within the solution. Thus, since the cathode is negatively charged, the hydrogen-ions must possess a positive charge. The hydrogen-ions are represented as H^+, and are called protons.

84. Hydronium-Ion.—The formation of the hydronium-ion, or oxonium-ion, H_3O^+, is based on the theory that the water decomposes the acid molecules by combining with one or both parts of each acid molecule to form "hydrated" ions. For example, if in the formation of dilute hydrochloric acid the water combined with the hydrogen of the acid, the reaction would be as follows:

$$\overbrace{\underset{\substack{\text{Hydrogen}\\\text{chloride gas}}}{HCl} \quad + \quad H_2O}^{H^+} \longrightarrow \underbrace{\underset{\text{Hydronium-ion}}{H_3O^+} \quad + \quad \underset{\text{Chloride-ion}}{Cl^-}}_{\text{Hydrochloric acid}}$$

This reaction accounts for the formation of ions by assuming that the hydrogen of hydrogen chloride, in combining with the water, carries a positive charge with it, thereby leaving the chlorine with a negative charge.

85. The theory is based on the fact that the very small size of the hydrogen-ion, or proton, H^+, enables it to come so close to other particles that it combines with them. This fact is substantiated by the additional fact that only solvents (such as water, alcohols, and liquid ammonia) that are chemically active, that is, those that combine with other substances, form a conducting solution when an acid is dissolved in them. The theory is summarized as follows: *When an acid is dissolved in water, a chemical reaction takes place in which the acid molecules transfer protons,* H^+, *to the water. The protons,* H^+, *combine with the water to form hydronium-ions,* H_3O^+, *and the remaining part of each acid molecule becomes negatively charged.*

86. Proton Transfer.—A reaction similar to that of hydrogen chloride gas and water is obtained when hydrogen chloride gas reacts with ammonia gas.

$$\overbrace{HCl \quad + \quad NH_3}^{H^+} \longrightarrow \underbrace{\underset{\text{Ammonium-ion}}{NH_4^+} \quad + \quad Cl^-}_{\text{Ammonium chloride}}$$

In this reaction the acid transfers the proton, H^+, to the ammonia gas, with which it combines to form the ammonium-ion, NH_4^+, and the chloride-ion is set free.

Reactions of the same type are obtained when other acids react with water or ammonia. For example, pure hydrogen bromide gas reacts with water as follows:

$$\overbrace{HBr \quad + \quad H_2O}^{H^+} \longrightarrow \underbrace{H_3O^+ \quad + \quad \underset{\text{Bromide-ion}}{Br^-}}_{\text{Hydrobromic acid}}$$

With hydrogen nitrate, or 100 per cent nitric acid, the reaction is as follows:

$$\overbrace{HNO_3 \quad + \quad H_2O}^{H^+} \longrightarrow \underbrace{H_3O^+ \quad + \quad \underset{\text{Nitrate-ion}}{NO_3^-}}_{\text{Nitric acid}}$$

87. With hydrogen sulfate, or 100 per cent sulfuric acid, the reaction takes place in two consecutive reactions, as shown by the following equations:

$$\overbrace{H_2SO_4 \quad + \quad H_2O}^{H^+} \longrightarrow \underbrace{H_3O^+ \quad + \quad \underset{\text{Acid sulfate-ion}}{HSO_4^-}}_{\text{Slightly dilute sulfuric acid}}$$

$$\overbrace{HSO_4^- \quad + \quad H_2O}^{H^+} \longrightarrow \underbrace{H_3O^+ \quad + \quad \underset{\text{Sulfate-ion}}{SO_4^=}}_{\text{Very dilute sulfuric acid}}$$

The corresponding reactions of hydrogen bromide and nitric acid with ammonia gas yield ammonium bromide and ammonium nitrate. Sulfuric acid reacts with ammonia gas, as with water, in two steps to produce first ammonium acid sulfate, $(NH_4)HSO_4$, and then ammonium sulfate, $(NH_4)_2SO_4$. In every case it is shown that the reaction consists in the transfer of protons, H^+, from the acid to the water.

88. A proton-transfer reaction, such as the transfer of protons by an acid to other substances, is called protolysis or a protolytic reaction. Acids are frequently classified as monoprotic (HCl), diprotic (H_2SO_4), and triprotic (H_3PO_4), according to the number of protons each acid molecule may transfer to another substance. Experiment has shown that each molecule of HCl, H_2SO_4, and H_3PO_4, transfer, in the order shown, one, two, and three protons to other substances, with which they react. Acids that transfer more than one proton per molecule are called polyprotic. Many times the terms *monobasic*, *dibasic*, *tribasic*, and *polybasic* are used instead of the corresponding terms just discussed.

89. Uses of Sulfuric Acid.—Extremely large quantities of sulfuric acid are used annually in almost every chemical industry, in which it finds a wide variety of uses. The estimated production of sulfuric acid in the United States in 1941 was a little over 11,000,000 short tons. About 23 per cent of the acid manufactured is used in the manufacture of fertilizers, such as ammonium sulfate, $(NH_4)_2SO_4$, and superphosphate, $Ca(H_2PO_4)_2$. About 16 per cent is used in the manufacture of sulfates, hydrochloric acid, nitric acid, sodium carbonate, and other chemicals. Large quantities of sulfuric acid, about 13 per cent, are used in the iron-and-steel industry. About 12.6 per cent of the acid is used in the refining of petroleum. Before it is distilled, the crude petroleum is washed with sulfuric acid, in order to remove the dark tarry substances. Other industries, such as those engaged in the manufacture of paints and pigments, rayon and cellulose film, industrial explosives, and textiles, use large amounts of sulfuric acid.

90. Sulfates.—Sulfates are salts of sulfuric acid. Since it is dibasic, sulfuric acid forms two series of salts, the normal and the acid salts. The normal salt, or sulfate, is a salt in which all of the hydrogen of the acid is replaced by a metal or group of elements, examples of which are sodium sulfate, Na_2SO_4, and ammonium sulfate, $(NH_4)_2SO_4$. The acid salt, or bisulfate, is a salt in which only one-half of the hydrogen of the acid is replaced by a metal or group of elements, examples of which are sodium bisulfate, $NaHSO_4$, and ammonium bisulfate, NH_4HSO_4.

91. A normal sulfate may be prepared by complete neutralization of the acid and evaporation. Complete neutralization may be accomplished by adding an equivalent amount of base to the acid. Thus,

$$H_2SO_4 + 2NaOH \longrightarrow Na_2SO_4 + 2H_2O \uparrow$$

A normal sulfate may also be prepared by the oxidation of a sulfide and by treating a metallic oxide with sulfur trioxide. For example,

$$CuS + 2O_2 \longrightarrow CuSO_4$$
$$CuO + SO_3 \longrightarrow CuSO_4$$

92. An acid sulfate, or bisulfate, may be prepared by partial neutralization of the acid and evaporation. The partial neutralization is accomplished by adding one equivalent weight of a base to the molecular weight of the acid. For example,

$$H_2SO_4 + NaOH \longrightarrow NaHSO_4 + H_2O \uparrow$$

An acid sulfate may also be prepared by distilling the salts of the more volatile acids, such as hydrochloric and nitric acids, with sulfuric acid. Thus,

$$NaCl + H_2SO_4 \longrightarrow NaHSO_4 + HCl \uparrow$$
$$NaNO_3 + H_2SO_4 \longrightarrow NaHSO_4 + HNO_3 \uparrow$$

93. Most sulfates are soluble in water, from which solution they crystallize very readily. In crystallizing from solution, some salts form hydrates, such as plaster of Paris, $CaSO_4 \cdot H_2O$, and epsom salts, $MgSO_4 \cdot 7H_2O$. The sulfates of silver and calcium are only slightly soluble in water, and those of lead, strontium, and barium are insoluble. The sulfates of the light metals are stable, but those of the heavy metals decompose, when heated, into the oxide of the metal and sulfur trioxide. For example,

$$CuSO_4 \longrightarrow CuO + SO_3$$

When heated with carbon, most sulfates are reduced to sulfides.

$$Na_2SO_4 + 4C \longrightarrow Na_2S + 4CO$$

94. Pyrosulfuric Acid.—Pyrosulfuric acid, $H_2S_2O_7$, which is also called oleum or fuming sulfuric acid, may be prepared by distilling partially dehydrated ferrous sulfate crystals, $FeSO_4 \cdot H_2O$, into a receiving flask containing concentrated sulfuric acid. When distilled, the partially dehydrated ferrous sulfate crystals decompose by two consecutive reactions. Thus,

$$6FeSO_4 \cdot H_2O \longrightarrow Fe_2(SO_4)_3 + 2Fe_2O_3 + 3SO_2 + 6H_2O$$
$$Fe_2(SO_4)_3 \longrightarrow Fe_2O_3 + 3SO_3$$

The liberated SO_3 combines with the concentrated sulfuric acid in the receiving flask, as in the following equation:

$$SO_3 + H_2SO_4 \longrightarrow H_2S_2O_7$$

Pyrosulfuric acid is also prepared by distilling sodium pyrosulfate with concentrated sulfuric acid. Thus,

$$Na_2S_2O_7 + 2H_2SO_4 \longrightarrow 2NaHSO_4 + H_2S_2O_7$$

Most of the commercial oleum is prepared by the contact process described in Art. 69.

95. Pyrosulfuric acid is a heavy, oily liquid that has a specific gravity of 1.9. The fuming of the acid is due to the escape of the excess sulfur trioxide. If heated, all of the excess sulfur trioxide volatilizes and concentrated sulfuric acid remains. When cooled, it forms crystals that melt at 35° C. Fuming sulfuric acid possesses all of the dehydrating and oxidizing powers of concentrated sulfuric acid in an accentuated form; and, because of these properties, it has many industrial uses. It is used in petroleum refining and in the manufacture of organic dyes, explosives, and many other substances.

96. Other Oxygen Acids of Sulfur.—Besides the important acids of sulfur already discussed, a number of other oxygen acids are known to exist either in the free state or as their salts. The names and the formulas of the acids, showing their relationship, are as follows:

Hyposulfurous acid,	$H_2S_2O_4$	Dithionic acid,	$H_2S_2O_6$
Sulfurous acid,	H_2SO_3	Trithionic acid,	$H_2S_3O_6$
Sulfuric acid,	H_2SO_4	Tetrathionic acid,	$H_2S_4O_6$
Thiosulfuric acid,	$H_2S_2O_3$	Pentathionic acid,	$H_2S_5O_6$
Persulfuric acid,	$H_2S_2O_8$	Hexathionic acid,	$H_2S_6O_6$

The "thio" acids derive their name from a Greek word meaning sulfur. Thiosulfuric acid is so named because it contains one atom of sulfur in place of one of the atoms of oxygen of sulfuric acid.

The polythionic acids form a series of five acids, which include the di-, tri-, tetra-, penta-, and hexathionic acids. Mention is made of these acids to show that they exist. However, since these acids and their salts are of minor importance, they will receive no further discussion.

97. Hyposulfurous Acid.—Pure hyposulfurous acid is not known. The zinc salt of hyposulfurous acid may be prepared by the action of zinc dust on a solution of sulfur dioxide in absolute alcohol.

$$Zn + 2SO_2 \longrightarrow ZnS_2O_4$$

When the salt zinc hyposulfite is dissolved in water, a solution of hyposulfurous acid is formed. The solution of the acid is a powerful bleaching agent and also exhibits active reducing properties.

Commercially, a solution of the sodium salt is prepared by the interaction of zinc with a sodium bisulfite solution of sulfur dioxide.

$$Zn + 2NaHSO_3 + SO_2 \longrightarrow Na_2S_2O_4 + ZnSO_3 + H_2O$$

The sodium salt is used industrially and in the chemical laboratory as a reducing agent. For instance, because of its reducing power, a solution of sodium hyposulfite is used to change indigo, an insoluble blue coloring compound, into indigo white, a coloring compound that is soluble in an alkaline solution. When soaked in this liquor and then exposed to air, a fabric is colored by the oxidation of the indigo white to its original indigo blue. This type of dye, of which there are many, is known as a vat dye. The reduction of these vat dyes by sodium hyposulfite makes the salt important to the dyeing industry.

98. Thiosulfuric Acid.—Thiosulfuric acid, $H_2S_2O_3$, does not exist in the pure state; but its salts, the thiosulfates, are in common use industrially and in the chemical laboratory.

The thiosulfates may be prepared by the oxidation of soluble sulfides and by the interaction of sulfur dioxide with sodium sulfide. Thus,

$$2K_2S_2 + 3O_2 \longrightarrow 2K_2S_2O_3$$
$$2Na_2S + 3SO_2 \longrightarrow 2Na_2S_2O_3 + S$$

Sodium thiosulfate, $Na_2S_2O_3$, also known as "hypo," is the most important salt of thiosulfuric acid. It may be prepared by boiling a solution of sodium sulfite with sulfur.

$$Na_2SO_3 + S \longrightarrow Na_2S_2O_3$$

Commercially, sodium thiosulfate, is prepared by treating a hot solution of sodium carbonate containing free sulfur with sulfur dioxide.

$$Na_2CO_3 + S + SO_2 \longrightarrow Na_2S_2O_3 + CO_2$$

By evaporating this solution, crystals of the pentahydrate, $Na_2S_2O_3 \cdot 5H_2O$, are obtained. This salt is very soluble in water and is used largely in photography as a fixing agent to remove the unchanged silver salt.

When strongly heated, the thiosulfates dissociate into sodium sulfate and sodium pentasulfide.

$$4Na_2S_2O_3 \xrightarrow{\Delta} 3Na_2SO_4 + Na_2S_5$$

The thiosulfates are also decomposed by mineral acids, with the evolution of sulfur dioxide and the formation of free sulfur.

$$Na_2S_2O_3 + 2HCl \longrightarrow 2NaCl + S + H_2O + SO_2 \uparrow$$

99. Persulfuric Acid.—Persulfuric acid, $H_2S_2O_8$, exists only in dilute solutions. However, its salts, the persulfates, are fairly stable and are used in photography to reduce negatives. The salts are prepared by electrolyzing a concentrated solution of sodium bisulfate, $NaHSO_4$, using a very high current density. The high current causes the salt to ionize as follows:

$$NaHSO_4 \longrightarrow Na^+ + HSO_4^-$$

The negative ions are attracted to the anode, where they give up their charge and combine in pairs to form persulfuric acid.

$$2HSO_4^- \longrightarrow H_2S_2O_8 + 2\ominus$$

The persulfuric acid formed interacts with the excess sodium bisulfate, and the less soluble sodium persulfate crystallizes out.

$$2NaHSO_4 + H_2S_2O_8 \longrightarrow Na_2S_2O_8 + 2H_2SO_4$$

Other persulfates are made from sodium persulfate by double decomposition.

Although the persulfates are fairly stable, they decompose very rapidly when heated, forming the respective pyrosulfate and evolving oxygen. For example,

$$2K_2S_2O_8 \xrightarrow{\Delta} 2K_2S_2O_7 + O_2$$

The persulfates are powerful oxidizing agents. They are used in analytical work, in bleaching, in photography, and in medicine.

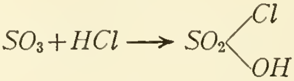
100. Sulfuryl Chloride.—Sulfuryl chloride, SO_2Cl_2, is prepared by exposing a mixture of sulfur dioxide and chlorine to the direct sunlight, in the presence of a little camphor. This reaction is given in Art. 56.

Sulfuryl chloride is a colorless liquid that boils at 69° C. It is readily decomposed by water, forming sulfuric and hydrochloric acids.

$$SO_2Cl_2+2H_2O \longrightarrow H_2SO_4+2HCl$$

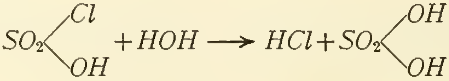
Sulfuryl chloride is the acid chloride of sulfuric acid, and it is used in the manufacture of organic acid chlorides.

101. Chlorosulfonic Acid.—Chlorosulfonic acid, $SO_2Cl\cdot OH$, may be prepared by treating sulfur trioxide with hydrogen chloride.



$$SO_3+HCl \longrightarrow SO_2\begin{cases}Cl\\OH\end{cases}$$

Chlorosulfonic acid is a heavy, colorless liquid that fumes in air and boils at 158° C. It is decomposed by water with explosive violence, forming a mixture of hydrochloric and sulfuric acids.



$$SO_2\begin{cases}Cl\\OH\end{cases}+HOH \longrightarrow HCl+SO_2\begin{cases}OH\\OH\end{cases}$$

Commercially, chlorosulfonic acid is used in the manufacture of saccharin.

102. Oxides and Oxygen Acids of Selenium.—Two oxides of selenium are known to exist; they are the dioxide, SeO_2, and the trioxide, SeO_3. Selenium dioxide may be prepared by burning selenium in dry oxygen or by evaporating a solution of selenious acid.

$$Se+O_2 \longrightarrow SeO_2$$
$$H_2SeO_3 \longrightarrow SeO_2+H_2O$$

Selenium dioxide is a white crystalline solid that sublimes at 300° C. It is the anhydride of selenious acid and it is used as an oxidizing agent in organic chemistry.

Selenium trioxide may be prepared by the action of oxygen on selenium, under the influence of a high frequency electric discharge. It is a white solid. It is very hygroscopic and has an acidic nature.

103. Selenious acid, H_2SeO_3, and selenic acid, H_2SeO_4, have been prepared. Selenious acid may be prepared by treating selenium with nitric acid.

$$Se+4HNO_3 \longrightarrow H_2SeO_3+H_2O+4NO_2$$

It is a colorless, crystalline solid. It is very soluble in water, forming a solution whose properties are similar to those of sulfurous acid. Selenious acid is reduced to selenium by sulfur dioxide, and is oxidized to selenic acid by chlorine or bromine.

Selenic acid, H_2SeO_4, may be prepared by oxidizing an aqueous solution of selenious acid with chlorine or bromine.

$$H_2SeO_3+H_2O+Cl_2 \longrightarrow H_2SeO_4+2HCl$$

Crystals of the acid can be obtained by careful evaporation of the solution. In many respects, the chemical properties of selenic acid are similar to those of sulfuric acid. It resembles sulfuric acid in that it reacts very vigorously with water. However, it is a much weaker acid and it is a rather unstable compound, decomposing into selenium dioxide and oxygen at temperatures much below its boiling point.

104. Oxides and Oxygen Acid of Tellurium.—Two oxides of tellurium, the dioxide, TeO_2, and the trioxide, TeO_3, have been prepared. Tellurium dioxide may be prepared by burning it in oxygen.

$$Te+O_2 \longrightarrow TeO_2$$

It is a colorless solid and it is slightly soluble in water. It is amphoteric, exhibiting basic properties by forming a basic nitrate, $TeO_2 \cdot HNO_3$, and acidic properties by reacting with alkali hydroxides to form solutions of tellurides.

Tellurium trioxide may be prepared by strongly heating telluric acid.

$$H_6TeO_6 \longrightarrow TeO_3+3H_2O$$

It is an orange-yellow, powdery substance. The remarkable feature of this oxide is that it will not recombine with water to form telluric acid.

105. The oxygen acids of tellurium that have been prepared are tellurous acid, H_2TeO_3, and telluric, H_6TeO_6. Tellurous acid is prepared by treating tellurium with a mixture of hydrochloric and nitric acids. Telluric acid is prepared by oxidizing the solution of tellurous acid by carefully adding small amounts of chloric acid. Crystals of the acid may be obtained by evaporating the oxidized solution in vacuo. The crystals may be purified by recrystallizing them from water.

106. Review of Sulfur Family.—The relationship of the sulfur family is best illustrated by the following facts. First, the properties of the elements and their compounds are so similar to one another that the properties of one element may be used to summarize the properties of the other elements of the family; secondly, in the gradual transition of the physical and chemical properties, the variation of any particular property always proceeds in the order of their increasing atomic weights. An examination of the physical and chemical properties will best illustrate the foregoing facts. The physical properties are listed in Table I.

TABLE I

PHYSICAL PROPERTIES OF SULFUR FAMILY

Properties	Sulfur	Selenium	Tellurium
Atomic weight	32.06	78.96	127.61
Physical state	Solid	Solid	Solid
Color of solid	Yellow	Red	Black
Specific gravity	1.96 to 2.07	4.28 to 4.8	6.0 to 6.25
Melting point	112.8° C. to 119.25° C.	217° C.	452° C.
Boiling point	444.6° C.	688° C.	1390° C.

Sulfur, selenium, and tellurium combine with hydrogen to form the respective hydrides. However, the speed of reaction or combination and the stability of the respective hydrides decreases as the atomic weight increases.

ELECTRONIC THEORY OF VALENCE

107. Introduction.—Although the subject of valence has already been discussed, considerable elucidation of the matter is possible when the structure of the atom is considered. As already shown, according to the theory developed by Lewis and Langmuir, the electrons surrounding the nucleus of the atom are arranged in successive concentric shells. In the case of hydrogen and helium, the planetary electrons occupy the first shell; since the additional electrons of the succeeding elements begin to occupy a second shell, it is assumed that only 2 electrons can occupy the first shell. Experiment has shown that only the electrons of the outer shell are involved in chemical reactions; and that the elements in the Periodic Table from lithium to neon have a tendency either to lose all of the electrons in the outer shell, or to gain electrons until a shell having 8 electrons is formed. The arrangement of the electrons in the second shell is shown in Fig. 10.

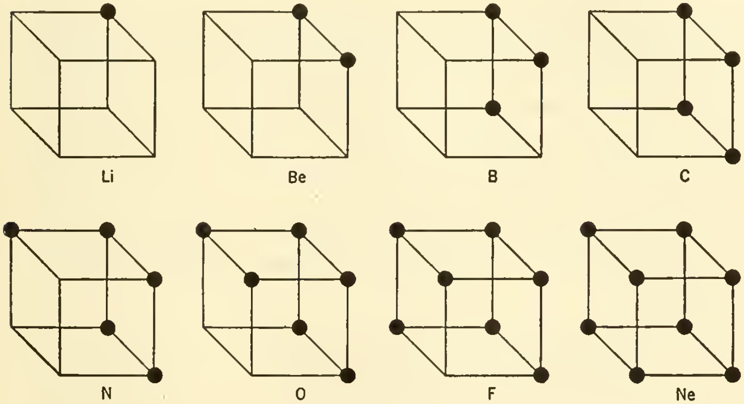


FIG. 10

108. The electrons are assumed to occupy the corners of an imaginary cube; in order to avoid confusion, the atomic nucleus and the electrons of the first shell are omitted from the diagrams in Fig. 10. Beyond the first period of hydrogen and helium, the valence electrons tend to go in a group of eight; therefore, no element has a valence of more than eight. The valence of elements is represented by the number of electrons that are lost (positive valence) or by the number of electrons that are gained (negative valence), in order to complete the outer shell of 8 electrons.

109. Types of Compounds.—With respect to the conductance of electricity, compounds are classified into two classes, namely, electrolytes and non-electrolytes. Electrolytic compounds ionize and conduct electricity and non-electrolytes do not ionize and are non-conductors of electricity. Hence, it is very evident that the valence linkages of electrolytes must differ in some important respect from the valence linkages of non-electrolytes. The valence linkage of electrolytes is accomplished by a transfer of electrons and is known as electrovalence, whereas the valence linkage of non-electrolytes is accomplished by a sharing of electrons and is known as covalence.

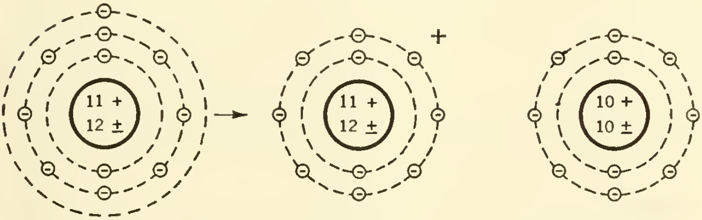
110. Electrovalence.—Electrovalence is the transfer of electrons by atoms in the formation of a compound. The theory of electrovalence applies to ionic, or electrolytic, substances and very successfully explains their behavior. The theory considers that the inert gas type of atomic structure is attained by the gain or loss of electrons. The loss or gain of electrons leaves the atom with an electronic configuration similar to the nearest inert gas, although the atom as a whole is different, that is, it is an ion and not an uncharged, or neutral, atom. The ions are then held together by electrostatic attractions.

111. For example, during the formation of sodium chloride by the reaction of sodium and chlorine, there is a transfer of an electron by the sodium to the chlorine atom. The number of electrons that an atom of an element can transfer is called its electrovalence. The resulting ions, Na^+ and Cl^-, assume electronic configurations that are similar to the neutral atoms of neon and argon, respectively, as shown in Fig. 11.

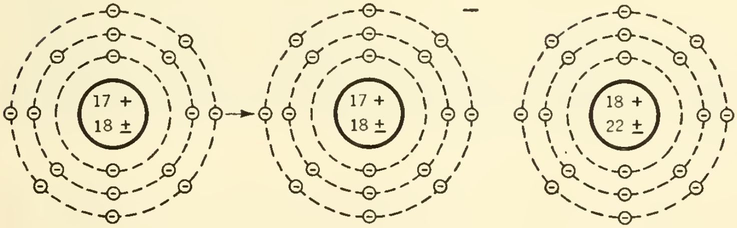
The formation of sodium chloride may be visualized as shown by the following equations:

$$\begin{array}{ccccccc} Na & + & Cl & \longrightarrow & Na^+ & + & Cl^- \\ (2,8,1) & & (2,8,7) & & (2,8)^+ & & (2,8,8)^- \\ & & & & \text{neon type} & & \text{argon type} \end{array}$$

$$Na^+ + Cl^- \longrightarrow Na^+Cl^-$$



Sodium Atom Sodium-ion Neon Atom



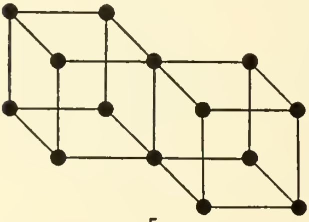
Chlorine Atom Chlorine-ion Argon Atom

Fig. 11

112. In solid sodium chloride, the ions are firmly held together by the electrostatic attraction of the ions, which is caused by their opposite but equal charge. This is also true of the ions in crystals of all other salts. However, when the salt is placed in a solvent, such as water, the electrostatic attractions of the ions are reduced because of the high dielectric constant of the solvent. The reduction of the electrostatic attractions causes the crystalline structure of the salt to break down and consequently the ions separate or go into solution.

The aqueous solution of sodium chloride is not considered to have any molecules of Na^+Cl^-, but instead only the ions Na^+ and Cl^-. These ions account for the chemical properties of the salt and for the electrical conductance and many other properties of its solution.

113. Covalence.—It has been shown that when combination takes place between two atoms, such as Na and Cl, by a transfer of electrons, a polar compound, such as Na^+Cl^-, is formed, in which the constituent ions are held together only by the electrostatic attractions of their opposite but equal charges. There is, however, a large group of substances to which the theory of electrovalence is clearly inapplicable. For instance, there is no reason why an atom of fluorine should lose one electron in favor of another fluorine atom in the formation of the fluorine molecule, F_2. Even if this were the case, the fluorine atoms would not assume the stable electronic configuration of the closest inert gas. This difficulty is experienced when dealing with all the non-ionizable substances.



F_2

FIG. 12

114. In order to obviate this difficulty, the theory of covalence was propounded. The theory assumes that the combination of the atoms occurs in such a way that the electronic configuration of the inert gas is achieved by the sharing of electrons. For example, the fluorine molecule is formed by the sharing of two electrons between the constituent atoms as shown in Fig. 12. In every case the electrons are shared in pairs, each of the atoms concerned generally contributing one of the pairs. The electronic formulas for some covalent compounds are shown in the following discussion. Only the electrons of the outer shell are shown. The electrons are represented by dots, and each pair of dots between two atoms constitute a single covalent bond.

115. For example, atoms of hydrogen and oxygen are represented as follows:

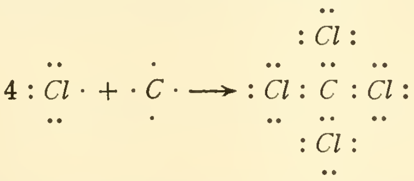
$$H\cdot \qquad :\overset{\cdot\cdot}{O}:$$

According to the theory of covalence, water is formed by the sharing of electrons between 2 hydrogen atoms and 1 oxygen atom. Hence, the electronic formula for water is as follows:

$$H:\overset{\cdot\cdot}{\underset{\cdot\cdot}{O}}:H$$

An examination of this formula will show that each hydrogen atom shares a pair of electrons with the oxygen atom, forming the stable group of eight electrons around the oxygen atom (neon type) and the stable group of two electrons around each hydrogen atom (helium type).

116. In like manner, one atom of carbon, having four electrons in its outer shell, combines with four atoms of chlorine, each having seven electrons in its outer shell, to form a molecule of carbon tetrachloride, CCl_4. Each of the chlorine atoms shares one of their electrons with one of the electrons of the carbon atom, so that the stable electronic configuration of the inert gas is attained by each atom. Thus,

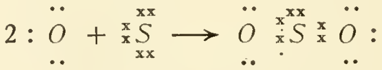


$$4:\overset{\cdot\cdot}{\underset{\cdot\cdot}{Cl}}\cdot + \cdot\overset{\cdot}{\underset{\cdot}{C}}\cdot \longrightarrow :\overset{\cdot\cdot}{\underset{\cdot\cdot}{Cl}}:\overset{\begin{array}{c}\cdot\cdot\\ :Cl:\\ \cdot\cdot\end{array}}{\underset{\begin{array}{c}\cdot\cdot\\ :Cl:\\ \cdot\cdot\end{array}}{C}}:\overset{\cdot\cdot}{\underset{\cdot\cdot}{Cl}}:$$

In the electronic formula of carbon tetrachloride, the carbon atom conforms to the neon type and each chlorine atom conforms to the argon type of electronic configuration. The foregoing discussion is summarized by stating that the covalence of an element represents the number of pairs of electrons that an atom of that element can share with atoms of other elements. For example, since each atom of carbon shares four pairs of electrons, one with each atom of chlorine, in the formation of carbon tetrachloride, its covalence is 4. On the other hand, the covalence of each chlorine atom is 1, since each atom shares only one pair of electrons.

117. Coordinate Valence.—Between the typical electrovalent, or ionic, substances and the covalent, or non-ionic, substances there are many substances that possess both electrovalent and covalent linkages. It has been shown that covalence is due to the sharing of a pair of electrons, one of the pair being contributed by each of the linking atoms. Combinations may occur, however, in which one atom contributes both electrons. This type of linkage is called coordinate linkage and utilizes what is known as coordinate valence. The atom that supplies the pair of electrons is called the donor and the atom that accepts the pair of electrons is called the acceptor.

118. The combination of sulfur and oxygen may be used to illustrate the theory of coordinate valence. Both sulfur and oxygen have six electrons in their outer shells. If an atom of sulfur shares a pair of electrons with one atom of oxygen and donates a pair of electrons to another atom of oxygen, a molecule of sulfur dioxide is formed, in which case each atom attains an electronic configuration of the inert gas type. By indicating the electrons of oxygen by a dot (.) and those of sulfur by an (x), the electronic formula is represented as follows:

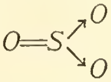


$$2:\underset{\cdot\cdot}{\overset{\cdot\cdot}{O}} + {}^{x}_{x}\underset{xx}{\overset{xx}{S}} \longrightarrow \underset{\cdot\cdot}{\overset{\cdot\cdot}{O}}\ {}^{x}_{\dot{x}}\underset{\cdot}{\overset{xx}{S}}\ {}^{x}_{x}\underset{\cdot\cdot}{\overset{\cdot\cdot}{O}}:$$

119. In molecules possessing coordinate valence, the donor atom is considered to be somewhat positive and the acceptor atom is considered to be negative. When writing the electronic formula of a substance having coordinate valence, it is convenient to represent the linkage by an arrow (→) instead of by the ordinary bond (—). The arrow represents two electrons and is arranged so that the head points away from the donor atom to the acceptor atom. Thus, using the arrow to indicate coordinate valence and the bond to indicate covalence, the electronic formula of sulfur dioxide is represented as follows:

$$O{=}S \rightarrow O$$

By similar reasoning, the electronic formula of sulfur trioxide is represented as follows:



An examination of the foregoing formulas will show that sulfur dioxide has two covalent linkages and one coordinate linkage, whereas sulfur trioxide has two covalent linkages and two coordinate linkages.

INORGANIC CHEMISTRY

Serial 5560G (PART 7) Edition 1

EXAMINATION QUESTIONS

Notice to Students.—*Study the Instruction Paper thoroughly before you attempt to answer these questions.* **Read each question carefully and be sure you understand it;** *then write the best answer you can. When your answers are completed, examine them closely, correct all the errors you can find, and* **see that every question is answered;** *then mail your work to us.*

Note.—Show how you obtain answers to questions that involve the solution of problems.

(1) Give six commercial uses of sulfur.

(2) (*a*) Define allotropy. (*b*) Given a quantity of sulfur, how would you prepare well-defined crystals of rhombic and monoclinic sulfur?

(3) Discuss the extraction of sulfur by the Frasch process.

(4) (*a*) How are sulfides classified? (*b*) Give an example of each class and explain how you would prepare a sulfide of each class.

(5) Given the salts, ferrous sulfide, FeS, ferrous selenide $FeSe$, and magnesium telluride, $MgTe$, formulate equations that represent the preparation of the following: (*a*) Hydrogen sulfide; (*b*) Hydrogen selenide; (*c*) Hydrogen telluride.

(6) (*a*) Define protolysis. (*b*) Formulate equations showing the protolytic reaction of HBr, HNO_3, and H_2SO_4 with ammonia gas, NH_3.

(7) (*a*) Which process should be chosen for the manufacture of highly concentrated sulfuric acid? (*b*) Briefly explain the process.

(8) In preparing a dilute solution of sulfuric acid, why is it safer to add the concentrated acid to the water, rather than the water to the acid?

(9) How many tons of 90 per cent pure iron pyrites would be required to make 10 tons of sulfuric acid containing 70 per cent H_2SO_4?

(10) (*a*) Define covalence. (*b*) Draw diagrams showing the arrangement of the electrons in the following molecules: NH_3, CH_4, and O_2.

(11) Given molar solutions of sodium hydroxide, $NaOH$, and sulfuric acid, H_2SO_4, how would you prepare the following: (*a*) sodium sulfate? (*b*) Sodium bisulfate?

(12) (*a*) What is the principle involved in the manufacture of sulfuric acid? (*b*) How is it accomplished in each of the processes for the manufacture of the acid?

(13) (*a*) What is a plane of symmetry? (*b*) Name the systems in which the crystals are classified.

(14) Discuss briefly the theory of the hydronium-ion formation.

(15) Given 2,000 pounds of sulfur, how many pounds of sodium thiosulfate can be prepared by the commercial method, assuming that the method is 100 per cent efficient?

Mail your work on this lesson as soon as you have finished it and looked it over carefully. DO NOT HOLD IT until another lesson is ready.

94738

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The Grade on this Lesson is B (en by M.f.

Write or print your name and address very plainly in the space provided.

Keep name and address between vertical dotted lines

INTERNATIONAL CORRESPONDENCE SCHOOLS

ANSWERS TO EXAMINATION QUESTIONS

Fill all blanks on first sheet of each lesson and blanks (1), (2), and (3) on all sheets.

(1) Sheet No. 1

(2) Name R H SCHACHT

St. and No., Box No., or R.F.D. No. 1103 7TH AVE SE

Post Office State or Country ROCHESTER, MINNESOTA

(3) Class Letters and No. EAAC 201389

Never Omit the Above

Subject CHARACTERISTICS OF D.C. MACHINES

No. 5496 Part 1 Edition

✓ correct

1. Remote control means stopping and starting a machine from some other location away from the machine.

—

2. A three wire DC generator uses slip rings and a balancer coil which are not used by 2 wire generators.
Incomplete See Art. 107.

3. A weak series field is used on some shunt motors to give an increase in field strength so (torque when) the motor slows down under heavier loads. Art. 2.

4. Back geared
Pedestal type mount
Wall and ceiling mount
Built ins.
Track mounting
Motors on slide rails. Art. 36.
Vertical motors. Art. 37.

5 (a) Separately excited generators are used when it is necessary to build up the voltage rapidly, and when a wide voltage variation is required. ✓
They are used on high voltage machines, because a shunt field would require many turns of fine wire and better

PHYSICS

(11 Parts)

5472-FIRST EDITION

QUESTION PAPER

Prepared especially for
INTERNATIONAL CORRESPONDENCE SCHOOLS

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SCRANTON, PA.

Printed in U. S. A.
1948

PHYSICS

Serial 5472 Edition 1

THE COURSE AND ITS STUDY

1. Textbook.--After careful consideration Black and Davis' Elementary Practical Physics has been chosen as the textbook for this Course in Physics, because the authors have presented the subject in such a manner as to make it not only practical but definite. The plates and figures are unusually illuminating and comprehensive.

For convenience, the textbook has been divided into eleven parts, and a set of questions has been prepared for each part. The pages of the textbook that are included in a part should be thoroughly understood before any attempt is made to answer the questions. Each lesson should be taken up in its regular order and only one set of answers should be sent in at a time.

2. The Importance of a Knowledge of Physics.--A knowledge of physics is of great practical importance. It is a source of real satisfaction to know how the machines with which we are familiar actually work. Such knowledge helps to stimulate in us a desire to know more about all of the things with which we come in contact. Anything that we can do to add to our sum total of knowledge will make us more effective in our practical work and more interesting to those who are about us.

3. Aim of the Course.--The primary object of this Course is to teach the student how to think accurately about familiar things. Since it is impossible to use laboratory work in teaching the underlying principles of physics by correspondence, we have been fortunate in finding a textbook that has drawn much of its illustrative material from the common devices in ordinary life and that contains remarkably clear illustrations of these devices, thus bringing out the points needed for a thorough understanding of the subject.

4. Method of Study.--In your study of a lesson, read the assignment thoughtfully, giving special attention to the mastery of the laws and principles presented. The explanations of the facts and principles given in the text will be of comparatively little value, however, unless you learn to make the practical application of them. After you have read the lesson carefully, read the summary at the end of the chapter to fix the principles firmly in your mind. Then reread the lesson. This second reading should make the points of the summary clear and vivid. The phrasing of the summaries is brief and definite so that it may be easily remembered and easily used.

After you have secured this preliminary knowledge, turn to the Question Paper and then, with a view to answering the questions, review the pages covered by the lesson. The black-faced words in the text have been used to call attention to the essential ideas and definitions. If these words suggest the ideas to your mind you can go on; if not, you should stop and read the paragraph again. Take up but one lesson at a time and when answering questions use your own words except for the laws, rules, and definitions. Your aim should be to give all that the question asks for and to make your answer complete and concise. If you criticize your own answers before sending them in, it will lessen the possibility of errors and make your study of much more benefit to you.

5. The Problems.--The very nature of the subject of physics requires for its mastery the solution of many numerical exercises. They help greatly to give definiteness to the student's ideas about physical phenomena. In the numerical computations it is sufficient, in general, to give the answers correct to three significant figures, as explained in the Appendix on page 700. By significant figures are meant the figures of a number starting with the first digit at the left and ending with the last digit at the right. It is understood that a cipher is considered as a figure but not as a digit. Ciphers, however, are significant figures if one or more occur between two digits. Thus, .045 has two significant figures, 405 has three significant figures, and $40.50 also has three significant figures. Since in solving the problems in the textbook the results are to be given correct to three significant figures, the constants π and $\frac{\pi}{4}$ are expressed correct to three significant figures and therefore written as 3.14 and .785. Logarithms or the slide rule may be used if desired. If you use the slide rule, be sure to mention it on each paper.

You will find it helpful to make a short mathematical review by studying what is given on pages 694 to 699 in the Appendix, and you should refer to these pages frequently. In addition to the hints on working problems given on page 699, the following suggestions are offered:

Factor as much as possible and let the actual multiplication and division be the last processes.

Get the habit of checking all your results.

Give complete solutions and not merely the numerical answers.

With the problems that have rather intricate solutions answers have been given, but for the more simple problems they are omitted, the purpose being to help you in the answers that are given, but not to give the hint that would take away all originality of solution.

6. The Questions.--The questions found interspersed through the entire book should be regarded as "prize puzzles" which it is an honor to solve, but no particular disgrace not to solve. The object of these questions is to lead the student to see that physics has much more to do with real life than is usually suspected. If you are interested in the correct answers to some of these questions and cannot figure them out for yourself we shall be glad to furnish the desired information.

There are some subjects taken up in the textbook that are difficult to understand without having the actual apparatus or machinery at hand.

These subjects must necessarily be included in any treatise on physics, and it is good for us to know something about them. The really essential principles have been brought to notice by the examination questions asked, but it will be well for the student to strive to work out some of the other problems and questions also. In nearly every town or city there is a high school that has a physics laboratory where some of the devices used to illustrate the principles of physics may be seen, and a visit to it will help to make your work more interesting and valuable than it would be by the study of the textbook alone.

PHYSICS

(Part 1)

Textbook.--"Elementary Practical Physics", by Black and Davis, Chapter 1, pages 1 to 17.

(1) What is the object of studying physics?

(2) Into what five divisions may physics be divided?

(3) (a) Name the two systems of weights and measures. (b) Which system is generally used in scientific work? (c) Why is this system used?

(4) (a) What is the meter? (b) What is the legal meter of the United States? (c) At what temperature is the length of the legal meter measured?

(5) Write the table of units of length of the metric system, giving the necessary abbreviations.

(6) Give the formula for finding the area of: (a) a rectangle; (b) a triangle; (c) a circle.

(7) Name several units of volume in both the English and metric systems.

(8) (a) How many centimeters in an inch? (b) How many inches in a meter? (c) How many quarts in a liter? (d) How many cubic inches in a gallon? (These equivalent values should be memorized.)

(9) Solve examples 2 and 3 on page 7 and examples 7, 8 and 12 on page 8.

(10) (a) What is the kilogram? (b) What is the gram?

(11) (a) How many milligrams in 1 gram? (b) How many grams in 1 kilogram? (c) How many pounds in 1 kilogram?

(12) (a) What does 1 cubic foot of water weigh? (b) What is the weight of 1 cubic centimeter of water?

(13) Solve examples 3, 4, 6, and 9 on page 11.

(14) (a) Define density. (b) What is the density of water in the English system? In the metric system?

Note. - In giving the density of a substance it is necessary to name the units of weight and volume considered. Thus, the density of copper is 0.321 pound per cubic inch, or 8.93 grams per cubic centimeter, not merely 0.321 or 8.93.

(15) (a) What is the simplest method of determining the density of any substance? (b) Express this method by means of a formula.

(16) Solve examples 1, 2, 5, and 7 on page 15.

(17) (a) How is the weight of a substance found when its density and volume are known? (b) The density of zinc is 7.1 grams per cubic centimeter. What is the weight of 20 cubic centimeters of zinc?

(18) Solve example 9 on page 15.

(19) A cylindrical railway water tank measures on the inside 10 feet in depth and 6 feet in diameter. How many tons of water does it hold?

(20) How would you determine the volume of an irregular piece of rock by means of a graduated cylinder, as in Fig. 1-9, partly filled with water?

Answers. - Ques. 13: (6) $11,400,000 (9) 20.7 lb.; Ques. 18: 1.75 ft.; Ques. 19: 8.82 tons.

PHYSICS

(Part 2)

Textbook.--"Elementary Practical Physics," by Black and Davis, Chapters 2 and 3, pages 18 to 70.

(1) (a) Give three reasons why we use machines. (b) What is the simplest machine? Give several examples. (c) A lever is a rigid bar turning about a fixed point of support. What is the point of support called?

(2) (a) In a lever with the fulcrum at one end, what is the measure of the turning effect of the weight about the fulcrum? (b) By what must this turning effect be balanced? (c) Solve examples 4 and 7 on page 22.

Suggestion. - Let x represent the unknown quantity in working these problems, and apply algebraic principles in solving the equations formed.

(3) (a) Upon what factors does the turning effect of the force depend? (b) Define the moment of a force. (c) State the principle of moments. (See the Italics in Art. 21.)

(4) Levers may be divided into three classes, depending upon the relative position of the fulcrum with respect to the two forces. (a) Draw diagrams to illustrate the three classes of levers and describe the location of the fulcrum with reference to the pull and the weight, (b) Name a practical illustration of each of these classes of levers.

(5) What two conditions must be fulfilled when several parallel forces are in equilibrium?

(6) Solve example 2 on page 28 and examples 7 and 8 on page 29.

(7) (a) Describe the method of finding the center of gravity of an irregular sheet of zinc by experiment. (b) Name several objects whose center of gravity does not lie within the substance of the body.

(8) Solve example 3 on page 33 and examples 6 and 10 on page 34.

(9) (a) State the formula used in computing the weight or pull in a wheel and axle. (b) Define a fixed pulley. (c) What is the mechanical advantage of a fixed pulley?

(10) (a) What is the mechanical advantage of a machine? (b) How do we find the mechanical advantage of any pair of pulley blocks?

(11) Solve examples 5 and 6 on page 40.

(12) (a) Define work. (b) How much work is done when a weight of 4 pounds is lifted 5 feet? (c) State the principle of work.

(13) Solve examples 3, 6, 7, 8, and 10 on page 48.

(14) (a) What is meant by the pitch of a screw? (b) In the case of the screw, what does the output equal, and what does the input equal? (c) What is the mechanical advantage of the screw?

(15) Solve examples 1 and 3 on page 52.

(16) (a) To what rate of working is the horsepower equal? (b) How is the horsepower of an engine computed?

(17) Solve examples 3, 5, 6, and 9 on page 57.

(18) (a) Define friction. (b) What are some of the advantages of friction?

(19) (a) What is the coefficient of friction? (b) Define the efficiency of a machine.

(20) (a) Solve examples 1, 3, and 4 on page 62. (b) Solve examples 1 and 3 on page 65.

Answers. - Ques. 8: (10) 5100 lb., 4400 lb.; Ques. 17: (3) 0.74 H.P. (5) 34 min. (6) 39.4 H.P.

(OVER)

PHYSICS

(Part 3)

Textbook.--"Elementary Practical Physics," by Black and Davis, Chapter 4, pages 71 to 108.

(1) (a) What is the distinction between pressure and force? (b) How are pressures usually expressed?

(2) (a) Give the rule for the total force for liquids in open vessels. (b) Solve examples 1, 3, 4, and 10 on page 76.

(3) (a) State the rule with reference to the upward pressure exerted by a liquid. (b) Solve example 13 on page 77.

(4) (a) State the rules with reference to sideways pressure. (b) Give the rule for calculating sideways force.

(5) Why do liquids seek their own level?

(6) Describe the water gauge of a steam boiler and explain the principle upon which it works.

(7) (a) Name the modern forms of waterwheels. (b) Under what conditions are the wheels generally used?

(8) (a) State Pascal's principle as given in Art. 70. (b) Explain what is shown by Fig. 4-23.

(9) Solve example 1 on page 93 and examples 2, 3, and 4 on page 94.

(10) (a) State Archimedes' principle. (b) Describe the experiment which shows the truth of the statement that a floating body displaces its own weight of the liquid in which it is floating.

(11) (a) Why can a person float? (b) Why can a steel ship float? (c) Solve example 8 on page 99.

(12) Solve examples 1 and 3 on page 98 and example 10 on page 99.

(13) A schoolboy in Holland is said to have saved his country from a flood by thrusting his arm into a hole in a dike 150 centimeters below the surface of the sea. Could a small body hold back the whole North Sea?

(14) (a) Define specific gravity. (b) State the difference between specific gravity and density, and show how the table on page 13 can be used as a table of specific gravities.

(15) Give the general rule for determining the specific gravity of a solid or a liquid.

(16) (a) Solve examples 1 and 2 on page 104 by applying the second method of Art. 78. (b) Solve example 9 on page 105 by applying the third method of Art. 78.

(17) Solve examples 4 and 8 on page 104.

(18) Solve example 10 on page 105.

(19) Describe the hydrometer.

(20) Solve example 14 on page 99.

Answers. -- Ques. 12: (10) 4160 lb.; Ques. 17: (10) 7.8

(OVER)

PHYSICS

(Part 4)

Textbook.--"Elementary Practical Physics," by Black and Davis, Chapters 5 and 6, pages 109 to 166.

(1) (a) Describe a simple experiment to show that air occupies space. (b) Describe an experiment showing that air has weight. (c) What is the weight of a cubic foot of air?

(2) (a) What is a perfect vacuum? (b) What is a partial vacuum? (c) Why cannot a perfect vacuum be created with a vacuum pump?

(3) (a) State several important uses of the vacuum pump. (b) Solve examples 1 and 3 on page 114 and example 4 on page 115.

(4) A tightly closed rubber bag partly inflated is placed under the receiver (as R, Fig. 5-2) of a vacuum pump, after which the air is pumped from the receiver. Explain fully the action of the bag.

(5) Describe Torricelli's experiment to measure the pressure of the atmosphere.

(6) Give a mathematical explanation of the use of the Torricellian tube to measure the pressure per square inch due to the weight of the atmosphere.

(7) (a) State two uses of the barometer. (b) Solve examples 2, 5, and 6 on page 122.

(8) What is the purpose of an air chamber on a pump?

(9) (a) Explain the construction and operation of the siphon, showing how to start it and what causes the flow of the liquid. (b) For what purpose is the siphon used?

(10) (a) What is it that pushes the water in a well up into a pump? (b) Why is the lifting effect of air more noticeable on a balloon than on a barrel of flour of the same size?

(11) (a) How is the total lift of a balloon computed? (b) Solve examples 4 and 5 on page 134.

(12) What characteristic of air is utilized in pneumatic tires, and of what two properties of air is it constituted?

(13) (a) State Boyle's law. (b) Write the formula expressing the law.

(14) Solve examples 1, 4, 6, and 8 on page 141.

(15) (a) Name the five kinds of stresses. (b) Name the kind of stresses that are acting on the following: Wires of a piano, table leg, belt, pump piston, and threads holding buttons on a coat.

(16) (a) Distinguish between the terms stress and strain. (b) State Hooke's Law. (c) Solve examples 2 and 3 on page 151.

(17) Define: (a) elastic limit; (b) breaking strength.

(18) (a) How are gas pressures explained? (b) Discuss the subject of the absorption of gases in solids.

(19) (a) Why does a falling drop of a liquid form a perfect sphere? (b) Distinguish between cohesion and adhesion.

(20) (a) What phenomenon causes the surfaces of liquids in small tubes to become convex or concave? (b) What sort of surface has water in a small glass tube?

Answers. - Ques. 11(b): (4) 181,000 lb. (5) 33,800 lb.; Ques. 14: (8) 96 cu. ft.

(OVER)

PHYSICS

(Part 5)

Textbook.--"Elementary Practical Physics," by Black and Davis, Chapters 7, 8, and 9, pages 167 to 216.

(1) Explain the representation of forces by arrows.

(2) State the principle of the parallelogram of forces which tells how to find the resultant and equilibrant of two or more forces acting at angles upon a point.

(3) As the angle between two forces becomes larger, how does the resultant change? Illustrate this by drawing three figures as in Fig. 7-5.

(4) Solve the example in Art. 129 by drawing the force diagram to a scale of 1 inch equals 2,000 pounds and measuring the length of the resultant.

(5) Solve examples 1, 4, and 6 on page 172 graphically.

(6) State the general rule with reference to the resolution of forces.

(7) Solve examples 1, 2, and 7 on page 177 graphically.

(8) (a) Solve example 1 on page 183. (b) Solve example 9 on page 185 graphically.

(9) (a) Define acceleration. (b) State the three laws of motion at constant acceleration. (c) Write the formulas expressing these laws.

(10) Solve examples 2, 3, and 4 on page 194.

(11) (a) To what is the average speed of a body starting from rest equal? (b) Solve examples 5, 6, 7, and 8 on page 195.

(12) Describe the experiment with a feather and a coin in a vacuum. What does this show?

(13) (a) What is the value of the acceleration of gravity? (b) Solve examples 3, 4, and 5 on page 200.

(14) Solve examples 1 and 4 on page 202.

(15) (a) State the first law of motion. (b) Define inertia.

(16) (a) What is the name applied to the force required to pull a revolving body in toward the center of the circle in which it is revolving? (b) Why do revolving emery wheels sometimes burst?

(17) (a) What is meant by an unbalanced force? (b) State the second law of motion.

(18) Solve examples 1, 2, 4, 5, and 7 on page 211.

(19) (a) State the third law of motion. (b) Give an illustration of this law.

(20) (a) Define mass and weight. (b) What is the unit of weight?

Answers. - Ques. 8(a): 0.487; Ques. 13(b): (3) (a) 14.3 sec. (b) 458 ft. per sec. (4) (a) 576 ft. (b) 6 sec.; Ques. 14: (4) 353 ft.; Ques. 18: (5) 3.75 tons. (7) 30 ft. per sec.

PHYSICS

(Part 6)

Textbook.--"Elementary Practical Physics," by Black and Davis, Chapters 10, 11, and 12, pages 217 to 268.

(1) Define: (a) energy; (b) potential energy; (c) kinetic energy.

(2) Derive the formula for kinetic energy as given in Art. 165.

(3) Solve examples 2, 4, and 7 on page 222 and example 10 on page 223.

(4) Show how both kinetic and potential energy are illustrated in the action of the simple pendulum.

(5) State the law of the conservation of energy.

(6) Solve examples 3 and 4 on page 226.

(7) (a) Name several sources of heat. (b) What liquid is used in thermometers for registering very low temperatures? Why? (c) Describe the clinical thermometer.

(8) (a) Change to centigrate: 150°F., - 10°F. (b) Change to Fahrenheit: 15°C., - 26°C.

(9) (a) Solve example 6 on page 236. (b) At what temperature do a centigrade and a Fahrenheit thermometer read the same? (Give an algebraic solution of this example.)

(10) Why is a gap usually left between the ends of the rails in building a railroad track?

(11) If a straight flat strip of brass is riveted to a smaller strip of iron, show by diagram the effect of moderately heating the combination, distinguishing the brass from the iron.

(12) Solve examples 2 and 5 on page 241.

(13) (a) What is the temperature of greatest density for water? (b) Define the coefficient of cubical expansion. (c) What is the coefficient of expansion for all gases?

(14) (a) Define absolute temperature. (b) Convert 20°C. to the corresponding absolute temperature.

(15) (a) Solve examples 1 and 2 on page 251. (b) Solve examples 4 and 5 on page 252.

(16) Explain the movement of convection currents.

(17) (a) Define convection. (b) In what two other ways is heat transmitted?

(18) Answer questions 1 and 2 on page 261.

(19) State and explain briefly the method of heat transference that is most effective in each of the following processes: (a) heating a flat iron; (b) heating the earth by the sun; (c) heating a room by a hot-air furnace.

(20) Answer questions 1 and 2 on page 266 and questions 6 and 8 on page 267.

Answers. - Ques. 3: (7) 59,000 ft.-tons; Ques. 6: (3) 4 min. 35 sec. (4) 20 ft. per sec.; Ques. 12: (2) 10 ft. 2.17 in. (5) 0.0000231; Ques. 15(a): (2) 11°C.; Ques. 15(b): (4) 2.82 liters. (5) 125 cu. ft.

PHYSICS

(Part 7)

Textbook.--"Elementary Practical Physics," by Black and Davis, Chapters 13, 14, 15, and 16, pages 269 to 367.

(1) Define: (a) British thermal unit; (b) calorie; (c) specific heat.

(2) Solve examples 2, 7, and 9 on page 272 and example 10 on page 273.

(3) (a) Explain the fact that, in an enclosed building, plants and vegetables can be kept from freezing during cold autumn nights by frequent watering. (b) Show by calculation how much heat is required to melt 1 gram of ice. See Art. 208.

(4) Solve examples 1, 3, 4, and 6 on page 279.

(5) (a) Define the boiling point of a liquid. (b) Explain the principle of a vacuum pan.

(6) (a) Define the process of distillation. (b) Solve examples 1 and 2 on page 285.

(7) Solve examples 1, 4, 5, and 9 on page 288.

(8) (a) How is evaporation different from boiling? (b) What is the dew point? (c) Explain the formation of dew on grass.

(9) (a) What is Joule's principle? (b) State the mechanical equivalent of heat for 1 B.t.u. and for 1 kilogram calorie.

(10) Solve examples 1, 2, and 8 on page 303.

(11) (a) What is meant by the capacity of a boiler? (b) What is the range of efficiency in modern boilers?

(12) What is the eccentric on a slide-valve engine, and how does it work?

(13) What is the essential difference between a steam engine and a gas or oil engine?

(14) Explain how a gas engine is water-cooled.

(15) (a) What are the poles of a magnet named? (b) State the laws of magnetic force: (1) as to like and unlike poles; (2) as to distance between the poles.

(16) (a) What is a line of force? (b) Explain the molecular theory of magnetism.

(17) (a) What is an important difference between magnetization and electrification? (b) Name three insulators. (c) Why can an insulator be easily electrified by friction?

(18) (a) For what purpose is an electroscope used? (b) Explain the action of the "gold-leaf" electroscope.

(19) (a) Explain the process of charging by induction. (b) What is a condenser? (c) Upon what does the capacity of a condenser depend?

(20) Describe the electrophorus and explain its action.

Answers. - Ques. 2: (7) 55°C. (9) 0.0933 (10) 988°C.; Ques. 4: (6) 20°C.; Ques. 6(b): (1) 100.33°C. (2) 741.1 mm.; Ques. 7: (4) 7260 calories (5) 197g. (9) 2516 lb.; Ques. 10: (8) 216,000 ft.-lb.

(OVER)

PHYSICS

(Part 8)

Textbook.--"Elementary Practical Physics," by Black and Davis, Chapters 17 and 18, pages 368 to 447.

(1) Give a description of the simplest form of electric cell and explain what is meant by the electrodes, the electrolyte, and the electric circuit.

(2) (a) What is electrical resistance? (b) What is the unit of resistance? (c) Define the volt.

(3) (a) State Ohm's law. (b) Express this law in symbols, explaining the meaning of each symbol.

(4) Solve examples 1 and 2 on page 379 and examples 4 and 6 on page 380.

(5) (a) For what are the ammeter and the voltmeter used? (b) How are they connected with the circuit?

(6) (a) Define the terms mil, circular mil, and mil foot. (b) Solve examples 2, 4, and 5 on page 386 and example 6 on page 387.

(7) (a) Draw a diagram of four cells when they are grouped: (1) in parallel, (2) in series. (b) State the conditions under which it is best to use each grouping in order to secure the greatest current.

(8) Describe the dry cell.

(9) Solve examples 3 and 5 (a, b) on page 400.

(10) (a) What is an electromagnet? (b) When is it a magnet? (c) Why is an iron core used? (d) State the rule for determining the polarity of an electromagnet.

(11) (a) Upon what does the strength of an electromagnet depend? (b) Why is it the custom to have an electromagnet in the shape of a horseshoe?

(12) Answer questions 1, 2, and 3 on page 417.

(13) (a) Define electrolysis. (b) To which electrode is the object to be plated connected? (c) What is electrolytic copper?

(14) (a) Upon what does the amount of metal deposited by a current depend? (b) What is meant by the electrochemical equivalent of a substance?

(15) Solve examples 1, 2, and 8 on page 428.

(16) Define the coulomb and the ampere in terms of their chemical effects.

(17) (a) What are some of the uses of the storage battery? (b) How should the condition of a storage battery be tested?

(18) Describe a fuse and explain the principles upon which it acts.

(19) (a) Define the watt. (b) Name the two units of electrical work.

(20) Solve examples 1, 2, 5, and 8 on page 435.

Answers. - Ques. 9: (3) 208 volts; Ques. 15: (8) 0.61 g.

PHYSICS

(Part 9)

Textbook.--"Elementary Practical Physics," by Black and Davis, Chapters 19, 20, and 21, pages 448 to 524.

(1) Upon what three factors does the amount of induced e.m.f. depend?

(2) (a) What is a generator? (b) What are its two essential parts?

(3) (a) What is an alternator? (b) Why is it possible to have an alternator with a stationary armature and a revolving field?

(4) (a) What is a direct current? (b) Name two purposes for which direct current is necessary.

(5) Solve examples 5 and 6 on page 461.

(6) (a) Of what parts does a motor consist? (b) What are some of the advantages of electrical transmission of power?

(7) Solve examples 6, 8, and 11 on page 469.

(8) (a) Answer question 1 on page 470 and question 9 on page 471. (b) Mention several ways of producing an e.m.f. in a wire.

(9) (a) When is an induced current set up in a coil? (b) Describe an induction coil.

(10) (a) What is the most important use of an induction coil? (b) What is meant by the inductance of a circuit?

(11) (a) What are the two coils of a transformer called? (b) In a step-down transformer, which coil is of fine wire? (c) Name two uses of transformers.

(12) Describe an experiment to show that sound cannot be propagated through a vacuum.

(13) (a) What is the velocity of sound in air at 0°C. and 76 centimeters pressure? (b) How does the velocity change with an increase in the temperature of the air?

(14) Solve examples 1, 2, 4, and 5 on page 507.

(15) (a) Explain the difference between transverse waves and longitudinal waves. (b) What are sound waves?

(16) Solve examples 1, 3, and 5 on page 516.

(17) (a) State the law for the variation in the intensity of sound. (b) Answer question 7 on page 524.

(18) Solve example 8 on page 524.

(19) What is an echo?

(20) Study the summary on page 523 and define (a) sound; (b) wave length; (c) frequency.

Answers. - Ques. 5: (6) 4.42 H.P.; Ques. 7: (8) 81% (11) 1.16 H.P.; Ques. 18: 2.78 : 1

(OVER)

PHYSICS

(Part 10)

Textbook.--"Elementary Practical Physics," by Black and Davis, Chapters 22 and 23, pages 525 to 578.

(1) (a) What are the three characteristics of a musical tone? (b) Upon what does each of these characteristics depend?

(2) In what ways may the loudness of a given sound be increased?

(3) Describe an experiment to illustrate resonance.

(4) (a) Distinguish between fundamentals and overtones. (b) What are harmonics?

(5) State the conditions under which sound beats produce (a) harmony; (b) discord.

(6) Solve examples 1, 2 and 3 on page 535.

(7) State three laws in accordance with which stretched strings vibrate.

(8) How does intensity of illumination vary?

(9) (a) What is the name of the unit of intensity for a source of light? (b) Solve example 4 on page 564.

(10) (a) For what purpose is a Bunsen photometer used? (b) Solve example 5 on page 564.

(11) (a) What is the unit of intensity of illumination? (b) Solve examples 10 and 11 on page 565.

(12) (a) State the law of reflection. (b) Make a diagram showing a plane mirror, an arrow, the image of the arrow, and the necessary four rays of light. Explain from your diagram the terms: incident ray, reflected ray, and normal.

(13) Explain the following terms used in reference to a curved mirror: principal focus, principal axis, center of curvature, focal length.

(14) Mention several uses of concave mirrors.

(15) (a) Construct a diagram showing the image of an object placed in front of a concave mirror, beyond the center of curvature. Explain the diagram as in Art. 452. (b) Describe the image formed.

Suggestion. - To locate the image of a point in a mirror, draw from the point a ray normal to the mirror and a ray parallel to the principal axis. The image is at the point where the two reflected rays cross.

(16) (a) Construct a diagram showing the image of an object placed in front of a convex mirror. Explain the diagram as in Art. 454. (b) Describe the image formed.

(17) (a) What are conjugate foci? (b) When an object is placed inside the principal focus of a concave mirror, what is the position and character of its image? Draw a figure to illustrate this case.

(18) (a) Write the mirror formula and explain the meaning of the symbols. (b) Solve examples 2, 3, 4, and 5 on page 574.

Suggestion. - Do not clear of fractions until the last in solving problems involving the mirror formula. Solve for $\frac{1}{D_o}$, $\frac{1}{D_i}$, or $\frac{1}{f}$ as need be, and then invert.

(19) Solve example 8 on page 574.

(20) Answer questions 3, 6, and 14 on page 578.

Answers. - Ques. 6: (3) 7.8 in.; Ques. 9(b): 100 candle power; Ques. 10(b): 36 candle power; Ques. 18(b): (3) 10 cm. (4) 40 in. (5) 30 cm., 10 cm.

(OVER)

PHYSICS

(Part 11)

Textbook.--"Elementary Practical Physics," by Black and Davis, Chapters 24, 25, 26, and 27, pages 579 to 690.

(1) (a) What happens when light passes from one substance to another of different density? (b) Explain how refraction of light must be considered in spearing a fish beneath the water by an oblique stroke of the spear.

(2) Explain, by diagram, the cause of total reflection, incidentally defining critical angle.

(3) Show by a diagram the path of a ray of light passing from left to right through a rectangular, parallel-sided glass plate. The incident ray should make an angle of about 45° with the edge of the plate. Describe the relation between the incident ray and the ray that emerges.

(4) (a) What is a lens? (b) Define its principal axis, its principal focus, and its focal length.

(5) Construct the image of an arrow formed by a double convex lens when the arrow is inside the principal focus. Describe the position and character of the image formed.

Suggestion. - To locate the image of a point formed by a lens, draw from the point a ray parallel to the principal axis and a ray passing through the center of the lens. The image is at the point where the rays meet after refraction by the lens.

(6) What is a camera?

(7) Describe the structure of the eye.

(8) (a) What is the magnifying power of a simple microscope? (b) Solve examples 10, 11, and 12 on page 616. (Use the formula of Art. 472.)

(9) (a) What is the cause of chromatic aberration? (b) How may it be remedied?

(10) Name the three main parts of a spectroscope and explain the purpose of each.

(11) What are the Fraunhofer lines?

(12) (a) Upon what does the color (1) of an opaque object depend; (2) of a transparent object? (b) Why does a photographer use a red lantern in working with sensitive plates? (c) Why does a mixture of yellow and blue pigments produce green?

(13) (a) What are cathode rays? (b) In what three ways does this radiation show itself?

(14) What are Roentgen rays, or X-rays?

(15) How can it be proved that X-rays are not the same as cathode rays?

(16) Name some of the uses of radium.

(17) Describe the experiment with the Leyden jars showing electric resonance.

(18) (a) What are Hertzian waves? (b) What is their velocity?

(19) Name and describe the parts of a three-electrode vacuum tube.

(20) How do radio waves differ from light waves in (1) velocity, (2) frequency, and (3) wave length?

Answers. - Ques. 8(b): (10) 50 in. (11) 30 ft.

Remove these two staples to separate the four sets of Examination Questions enclosed.

Send the Examination Questions one set at a time.

Assignments
and
Examination Questions

GENERAL SCIENCE

Parts 1-4

Lessons 5896A-D

Edition 1

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1947

GENERAL SCIENCE

"The world is so full of a number of things" that the questions How? Why? and What? are asked continually. A course in General Science gives answers to many of these questions. Some questions are too difficult to take up in it and are answered in more advanced courses, while others are as yet unanswerable and scientists are working to find explanations.

Is it important to know the answers to these questions? If some one had not asked Why? and How? there would probably be epidemics of smallpox and diphtheria as frequently as there were fifty years ago. If some one had not asked Why? and How? we would have no automobiles, no airplanes, no telegraph, no machines of any kind; we could not have a variety of food, both fresh and preserved; we would have no great buildings. In fact, we would be living as people lived hundreds of years ago with no comforts or conveniences.

Scientific knowledge has been classified and divided into many branches, to each of which is given a name. Chemistry tells of the substances of which things are made and of what happens when they are combined or broken up to form other substances. Physics tells of the forms of energy and how they work. Astronomy tells of the heavenly bodies and the earth's relation to them. Physical Geography tells of the earth's surface and its changes. Geology tells of the structure and history of the earth's surface. Biology, the science of living things, is divided into Zoology which is the study of animals, Botany which is the study of plants, and Physiology which is the study of our bodies. To make up a course in General Science parts of each of these branches are chosen that will help you in understanding and using the common things about you. By referring to this list you can tell which branch you should study further if you wish to know more about a particular subject.

The things you will learn in General Science will also help you to understand better much that you read in newspapers and magazines. Your attention will be drawn to articles that you would scarcely have noticed before. You will find it interesting to keep a notebook or scrapbook in which you can paste pictures and other clippings and in which you can write out the main points of articles that you cannot cut from the papers. The material in such a notebook should be arranged according to some definite plan. It might be convenient to use the same general order as is used in the textbook. Then you could easily refer from one to the other.

STUDY HELPS

How to Study.--The purpose of these suggestions is to help you to know how to study your lessons so as to get the most out of them.

a. Know your Textbook. During your first study period, leaf through the textbook or lesson pamphlet several times in order to ascertain what it contains. If the textbook contains a Preface, read that and scrutinize the Table of Contents and the Index. Observe closely any special material given, such as Questions for Review, Special Topics, Self Tests, Thought Exercises, Questions, Problems, Projects, or Reports and References for Reading. Usually these are at the end of each chapter or near the end of the textbook. Become thoroughly familiar with the make-up of your textbook or your lesson pamphlet.

You should also familiarize yourself with the make-up of the separate sets of examination questions for at the beginning of each of these you will find your assignment for the lesson.

b. Note carefully what pages your lesson covers and also the headings of the chapters included. These chapter topics give a preliminary idea of the subjects to be considered. They frequently contain the "meat" of the discussion.

c. Read rapidly all the material covered in the assignment, in order to acquire a general view of the topic or topics. In this first reading, seek for the principal thought.

d. Reread each chapter critically, paragraph by paragraph, so as to get the details. Relate these to the general or main topic. Accompany this reading by the noting of paragraph headings, by the marking of important points, and by the making of a list of new names or unfamiliar terms. Look up in a dictionary the meanings of all unfamiliar words.

e. Close your book or lesson pamphlet and see how much you remember of what you study. If you find that you do not remember the major points, review the paragraph or paragraphs in which these points are discussed.

f. If there are questions, exercises, or other homework given at the end of the chapter or throughout the lesson, prepare this work and make up a few good questions concerning the essential points stressed. Do not, however, send any of this work to us for correction since this material is for home study only.

g. Whenever you have an opportunity, read other texts pertaining to the subject you are studying. No one text can include all information concerning any topic. The best textbook can give only the core or background of the subject. You should elaborate upon the information given, by drawing upon other sources and by finding what other authorities say concerning the topic.

(OVER)

If there are bibliographies or lists of books included in the text, they will suggest excellent supplementary reading material. You can borrow some of these books from your public library.

h. Whenever possible, tell aloud to yourself or to some friend the story of the lesson, trying to give this story in a connected manner and with proper emphasis on the important points.

i. Use judgment as well as memory. Determine what is significant and what is of minor value. Underline important statements. Correlate these points and see what contrasts or comparisons you can make. Associate, if possible, the discussions in the lesson with those of a preceding lesson. This association of material will help you to acquire a broader, more connected viewpoint and enable you to draw wiser conclusions; it will also fix the lesson material more firmly in your mind.

j. Consciously, consistently and persistently try to increase your efficiency.

PREPARING AND SENDING LESSONS FOR CORRECTION

What to Do.--When you have studied the part of your text assigned as your lesson, close your textbook or lesson pamphlet and take up the examination questions pertaining to that lesson. Prepare answers to the questions asked, mailing the lesson as soon as you complete it.

When you come to the examination questions of your first lesson you will notice that there are two types of questions--essay and objective. The first few questions of each lesson will be of the essay type. These are evaluation of what is commonly called "thought" questions; that is, you will be required to recall certain parts of the lesson you have studied and write several sentences or several paragraphs about that part of the lesson. You will have to answer these questions on separate sheets of paper, preferably 8 1/2 inches by 11 inches in size. Be sure that each sentence is a grammatically complete sentence. The remaining questions will be of the objective type where you will be required to fill in blanks on the same paper on which the question is asked. Do not use separate sheets of paper for these questions. Return the sheet on which the examination questions are written, with all of the blanks properly filled in. There may be several types of objective questions in each lesson, such as completion (fill in a word to complete the meaning of the sentence), multiple choice (select the proper word or phrase which will correctly complete or answer the question, matching (select the proper word or phrase from a second column and place the correct designating number in the first column after the word or phrase to which it pertains), and true and false (indicate whether the statement is true or false by placing the correct designation in the parenthesis at the end of each statement). Separate instructions are placed at the beginning of each of these questions.

In all the lessons, the essay-type questions are to be answered on separate sheets of paper and the objective-type questions are to be answered on the same paper on which the question is asked.

Always read each question critically, making certain that you understand it and know exactly what is required.

Formulate in your own mind the answer you will give. Do not use the exact language of your text, but express your ideas in words of your own choosing. This is important.

Write the answer, giving it definitely but concisely. Use complete sentences except in cases where a specific type of answer is required.

Look over each answer in order to determine whether you have given it in the best form possible. If you find errors, eliminate them. If you have given matter not pertinent to the question, omit this matter. If you have not answered the question fully, add whatever is necessary. In all cases collect your ideas and discard those which are non-essential. Then write the revised answer.

If you find yourself unable to answer a question or feel that your knowledge of it is somewhat inadequate, review that part of your text which pertains to the subject involved. Then after you have closed your textbook, or lesson pamphlet, write the best answer you can. Do not fail to answer any question or a part of any question. Your instructor will be obliged to reduce your grade accordingly for unanswered questions. If a sufficient number of questions are unanswered the lesson will be returned with suggestions of where you may find the material to answer the question satisfactorily. However, if such a lesson is returned it means that the grade will be withheld and valuable time will be lost.

Take pains with all your work. Write neatly and legibly and arrange your answers in good form. If the lessons are typewritten, all answers should be doubled-spaced to allow room for comments by the instructor. Remember that in every examination you should aim to have the spelling, the capitalization, the punctuation, and the language as nearly correct as possible.

INTERNATIONAL CORRESPONDENCE SCHOOLS

The Grade on this Lesson is............ *Given by*....................

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GENERAL SCIENCE

(PART I)

The World of Science

The Air and Man's Uses of It

Lesson 5896-A Edition 1

ASSIGNMENT -- Study the text material in Chapters One to Three, pages 3 to 55 in "Everyday Science" by Caldwell and Curtis. Consult the glossary which begins on page 629 for definitions of words and terms.

EXAMINATION QUESTIONS

(1) (a) What are scientific attitudes? (b) What are principles of science?

(2) Define: (a) environment; (b) chemistry; (c) matter.

(3) Describe the function of air pressure in regard to the vacuum cleaner.

(4) Describe in detail the difference between compressed air and a partial vacuum.

(5) Summarize the progress that has been made in exploring the atmosphere.

(6) Define and give an example of each of the following: (a) rapid oxidation; (b) slow oxidation.

(7) The following groups of words define or characterize one of the terms listed below. Place the number of the term in the parenthesis opposite the group that defines or characterizes it.

(a) One of the most important discoveries in human history_( )

(b) A space that is completely empty_____________________( )

(OVER)

(c) A general name given to all substances ______________( )

(d) One of the most important inventions in the history of the world ______________( )

(e) Useful knowledge ______________( )

(f) Rusting of iron ______________( )

(g) Cause of bodies to have weight ______________( )

(h) Pressure of water at a depth of 34 feet ______________( )

(i) Mixture of dust and gases surrounding the earth ______________( )

(j) Explosions and burning ______________( )

TERMS

1. One atmosphere
2. Oxidation
3. Electric lamp
4. Air
5. Scientific knowledge
6. Gravity
7. Vacuum
8. Rapid oxidation
9. Superstitions
10. Fire
11. Three atmospheres
12. Matter

(8) Read the following statements and write in the parenthesis at the right a plus (+) if it is true or a zero (0) if it is false.

(a) Galileo was the first scientist to use the mercury barometer in studying air pressure ______________( )

(b) About one-quarter of all the air is below an altitude of three and a half to four miles ______________( )

(c) The most common type of barometer is the aneroid barometer ______________( )

(d) When we breathe, we take in all the substances composing the air, but we make use of carbon dioxide only ______________( )

(e) Oxygen is necessary in the life processes of practically all animals and plants ______________( )

(f) Carbon dioxide results from the oxidation of materials within the bodies of plants and animals ______________( )

(g) Only a few objects upon the earth's surface contain some water ______________( )

(h) Suction is never a push but always a pull ______________( )

(i) A lift pump will rarely lift water more than twenty-five to twenty-eight feet ______________( )

(j) Scientific knowledge is built from the facts that people learn about the things in their environment_______________( )

(9) Each of the following statements is followed by a group of words or clauses. Select the word or clause that you feel correctly completes the statement, and place its number in the parenthesis at the right.

(a) Scientists have proved that at sea level mercury will always rise in a barometer tube (1) 15 inches, (2) 25 inches, (3) 30 inches, (4) 40 inches_______________( )

(b) The aneroid barometer that keeps a permanent record of air pressure is called (1) barograph, (2) inkograph, (3) barometer_( )

(c) By observations of "shooting stars" (meteors) scientists have estimated the depth of the air to be at least (1) 200 feet, (2) 150 miles, (3) 200 miles, (4) 400 miles_______________( )

(d) The ditch that is considered to be the greatest in the world is (1) Panama Canal, (2) Grand Canyon, (3) Mississippi River, (4) Suez Canal_______________( )

(e) The percentage of nitrogen in the air is approximately (1) 56, (2) 65, (3) 78, (4) 92_______________( )

(f) The amount of pressure applied per square inch by 3 atmospheres is equal to (1) 30 lb, (2) 35 lb, (3) 140 lb, (4) 45 lb( )

(g) The gas used in dirigibles is (1) carbon dioxide, (2) helium, (3) warm air, (4) neon_______________( )

(h) If all the air were pumped from a tin can, the can would (1) burst, (2) collapse, (3) keep its initial shape__________( )

(i) A gas that is a necessary part of many food substances that are required by both plants and animals is (1) nitrogen, (2) argon, (3) neon, (4) helium_______________( )

(j) Combustion and the breathing of animals add to the air great quantities of (1) nitrogen, (2) oxygen, (3) argon, (4) carbon dioxide_______________( )

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INTERNATIONAL CORRESPONDENCE SCHOOLS 99

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Write or print your name and address plainly in the space below.

Keep name and address between vertical dotted lines

Class Letters and No. ....

Name..........
St. and No. Box No. or R. F. D. No...........
Post Office State or Country.......... (......) Zone No.

GENERAL SCIENCE

(PART VI)

The Changing Earth and The Wealth Within It

Lesson 5896-F Edition 1

ASSIGNMENT -- Study the text material in Chapters Eighteen and Nineteen, pages 287 to 323 in "Everyday Science" by Caldwell and Curtis. Consult the glossary which begins on page 629 for definitions of words and terms.

EXAMINATION QUESTIONS

(1) (a) What is the difference between organic and inorganic matter? (b) Give an example of each.

(2) (a) How are metamorphic rocks formed?
(b) What conditions cause igneous rocks to form new and different rocks?

(3) Summarize the difference between cement, concrete, and stucco.

(4) At the present time, what kinds of natural stone find use in buildings?

(5) Why are fossils important?

(6) Name five agents of weathering.

(7) How is soil formed?

(8) The following groups of words define or characterize one of the terms listed below. Place the number of the term in the parenthesis opposite the group that defines or characterizes it.

(a) Shifting of enormous quantities of rock and soil__________( )

(OVER)

(b) Everything that is not organic ____________________ (   )

(c) Mixture of many compounds of carbon and hydrogen ____________________ (   )

(d) A sedimentary rock ____________________ (   )

(e) A metamorphic rock ____________________ (   )

(f) Forms or remains of ancient animals or plants preserved in earth or rock ____________________ (   )

(g) A small solid body in the heavens ____________________ (   )

(h) Gray or brown plants that stick to the surfaces of rocks and grow into scalelike masses ____________________ (   )

(i) Product of cast iron ____________________ (   )

(j) Increased as the size of the earth increased ____________________ (   )

TERMS

1. Limestone
2. Fossils
3. Steel
4. Planetesimal
5. Erosion
6. Marble
7. Lichens
8. Inorganic
9. Petroleum
10. Gravity

(9) Read the following statements and write in the parenthesis at the right a plus (+) if it is true or a zero (0) if it is false.

(a) It is estimated that all the rivers in North America are lowering the average level of the continent at a rate of about an inch every seven hundred and fifty years ____________________ (   )

(b) The constant pull of gravity on rocks is never strong enough to cause them to break or fall ____________________ (   )

(c) Transported soil is always eroded soil ____________________ (   )

(d) Most of the coal in the United States is anthracite ____________________ (   )

(e) The most valuable of the products made from petroleum is soap ____________________ (   )

(f) Steel is made by adding to iron a small percentage of aluminum ____________________ (   )

(g) If there were no heat within the earth there would be no geysers ____________________ (   )

(h) Natural gas is found where coal is found ____________________ (   )

(i) The sedimentary rocks were made possible by the "wrinkling" process________________________________( )

(j) When a swiftly moving stream empties into a quiet lake, the finer particles of sediment are dropped farthest from the shore________________________________( )

(10) Each of the following statements are followed by a group of words or clauses. Select the word or clause that you feel correctly completes the statement and place its number in the parenthesis at the right.

(a) According to the planetesimal hypothesis, the earth began as a part of a (1) meteor, (2) planet, (3) spiral nebula, (4) comet________________________________( )

(b) Many valuable products are obtained from crude petroleum by the process of (1) evaporation, (2) distillation, (3) condensation, (4) oxidation________________________________( )

(c) An example of organic matter is (1) a fingernail, (2) gold, (3) water, (4) eroded rock________________________________( )

(d) The most useful product obtained from petroleum is (1) paraffin, (2) gasoline, (3) fuel oil, (4) benzine______________( )

(e) A substance that consists of pure crystallized carbon is (1) pearl, (2) coal, (3) limestone, (4) diamond________________( )

(f) All glass contains (1) clay, (2) lead, (3) sand, (4) soil_( )

(g) The most valuable artificial rock used in the construction of great buildings, dams, and the like is (1) concrete, (2) asbestos, (3) stucco, (4) slate________________________________( )

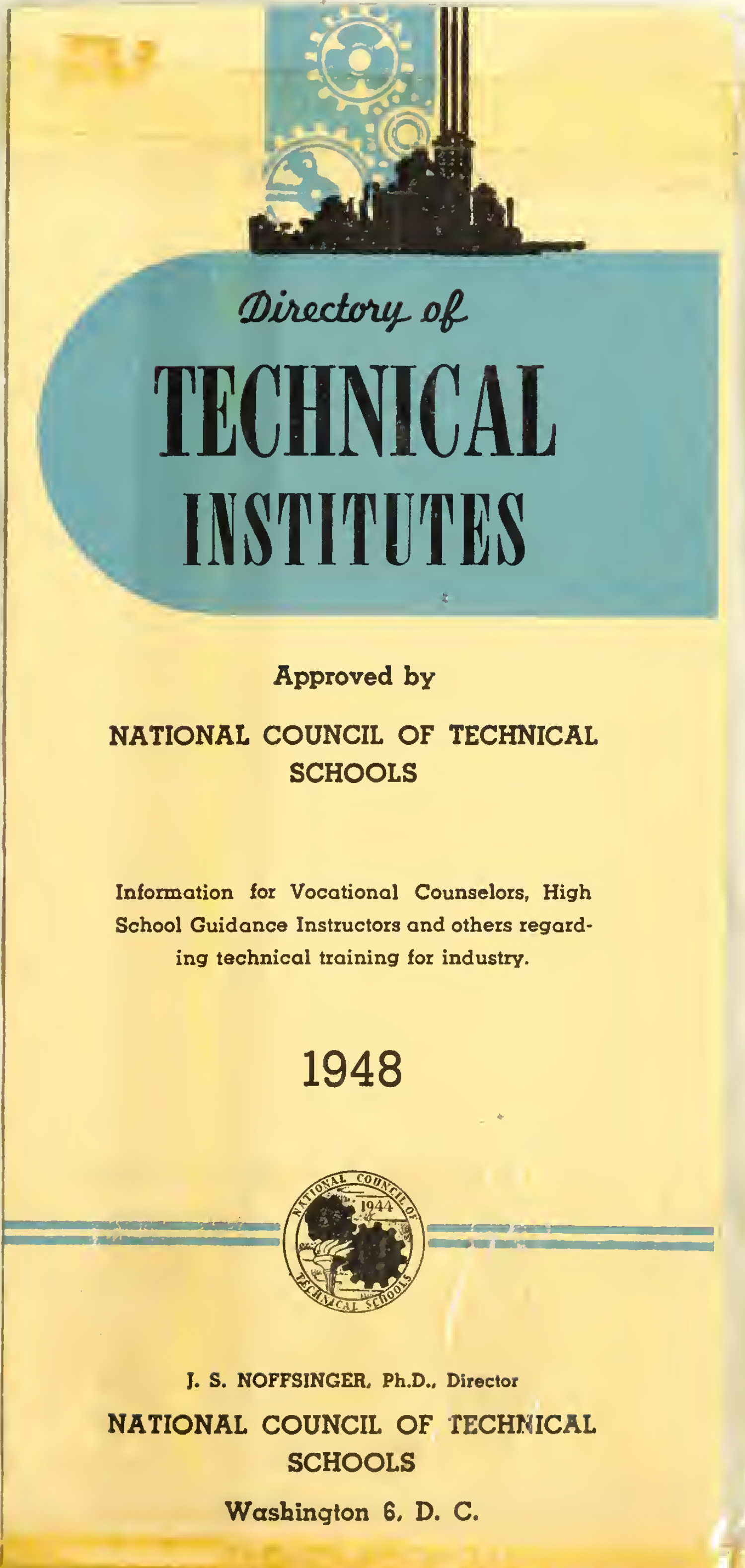
(h) Scientists now believe that in order for the earth to be in its present condition it must be (1) a hundred years old, (2) a thousand years old, (3) a million years old, (4) a billion years old________________________________( )

(i) According to the planetesimal hypothesis, the central mass in the nebula from which the solar system developed became (1) the planet Jupiter, (2) the sun, (3) a comet, (4) the earth___( )

(j) Metamorphic rocks are formed from (1) sedimentary rocks, (2) igneous rocks, (3) both sedimentary and igneous rocks, (4) fossils________________________________( )

BROCHURE V

DIRECTORY OF TECHNICAL INSTITUTES



Directory of

TECHNICAL INSTITUTES

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NATIONAL COUNCIL OF TECHNICAL SCHOOLS

Information for Vocational Counselors, High School Guidance Instructors and others regarding technical training for industry.

1948

1944

J. S. NOFFSINGER, Ph.D., Director

NATIONAL COUNCIL OF TECHNICAL SCHOOLS

Washington 6, D. C.

PLACE AND FUNCTION OF THE TECHNICAL INSTITUTE

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In the April, 1944 report of the Subcommittee on Technical Institutes of Engineers' Council for Professional Development, it is stated:

> "A number of independent studies of technical institute education have disclosed that industry needs and can advantageously employ at least three times as many technical institute graduates as they can four-year engineering college graduates. Since the output of the technical institutes falls short of this number and the needs of industries must be served, many engineering graduates are employed for positions requiring less extensive and less fundamental training than that provided by the degree conferring college. This is a waste both of educational facilities and of young people."

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APPROVED SCHOOLS AND COURSES

1. **Academy of Aeronautics, New York Municipal Airport, La Guardia Field, New York.**
   Approved Courses: Aircraft Mechanics and Maintenance, Aircraft Design and Construction.
2. **Aero Industries Technical Institute, Oakland Municipal Airport, Oakland 14, California.**
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3. **The Aeronautical University, Inc., 116 S. Michigan Avenue, Chicago 3, Illinois.**
   Approved Courses: Aeronautical Engineering, Aeronautical Engineering Drafting; Certified Engine Mechanics.
   OTHER COURSES OFFERED: *Airplane and Engine Refresher, and Aviation Administration.*
4. **American School of Aircraft Instruments, 5145 West San Fernando Road, Los Angeles 26, California.**
   Approved Courses: Master Aircraft Instruments.
5. **American School of Watchmaking, 5145 West San Fernando Road, Los Angeles 26, California.**
   Approved Courses: Master Watchmaking.

6. **Bliss Electrical School, 7533 Takoma Avenue, Takoma Park, Washington 12, D. C.**
    Approved Course: Fundamentals of Industrial Electrical Engineering.
7. **Bowman Technical School, Duke & Chestnut Streets, Lancaster, Pennsylvania.**
    Approved Courses: Watchmaking and Repairing
    OTHER COURSES OFFERED: *Jewelry Repair and Stone Setting, and Engraving.*
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14. **Lincoln Aviation Institute, Union Air Terminal, Lincoln, Nebraska.**
    Approved Courses: Master Aviation Mechanics.
    OTHER COURSES OFFERED: *Refresher Airplane & Engine Mechanics.*
15. **Milwaukee School of Engineering, 1020 North Broadway, Milwaukee, Wisconsin.**
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    OTHER COURSES OFFERED: *Aircraft and Gas Welding, Drafting, Electric Arc Welding, Heating, Practical Electricity, and Refrigeration and Air Conditioning.*
16. **National Schools, 4000 S. Figueroa Street, Los Angeles 37, California.**
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    Approved Courses: Aeronautical Engineering I, Aeronautical Engineering II, Aircraft and Engine Mechanics.

18. **Plastics Industries Technical Institute, 1601 South Western Avenue, Los Angeles 6, California.**
    Approved Courses: Basic Plastics Technology, Advanced Plastic Technology.

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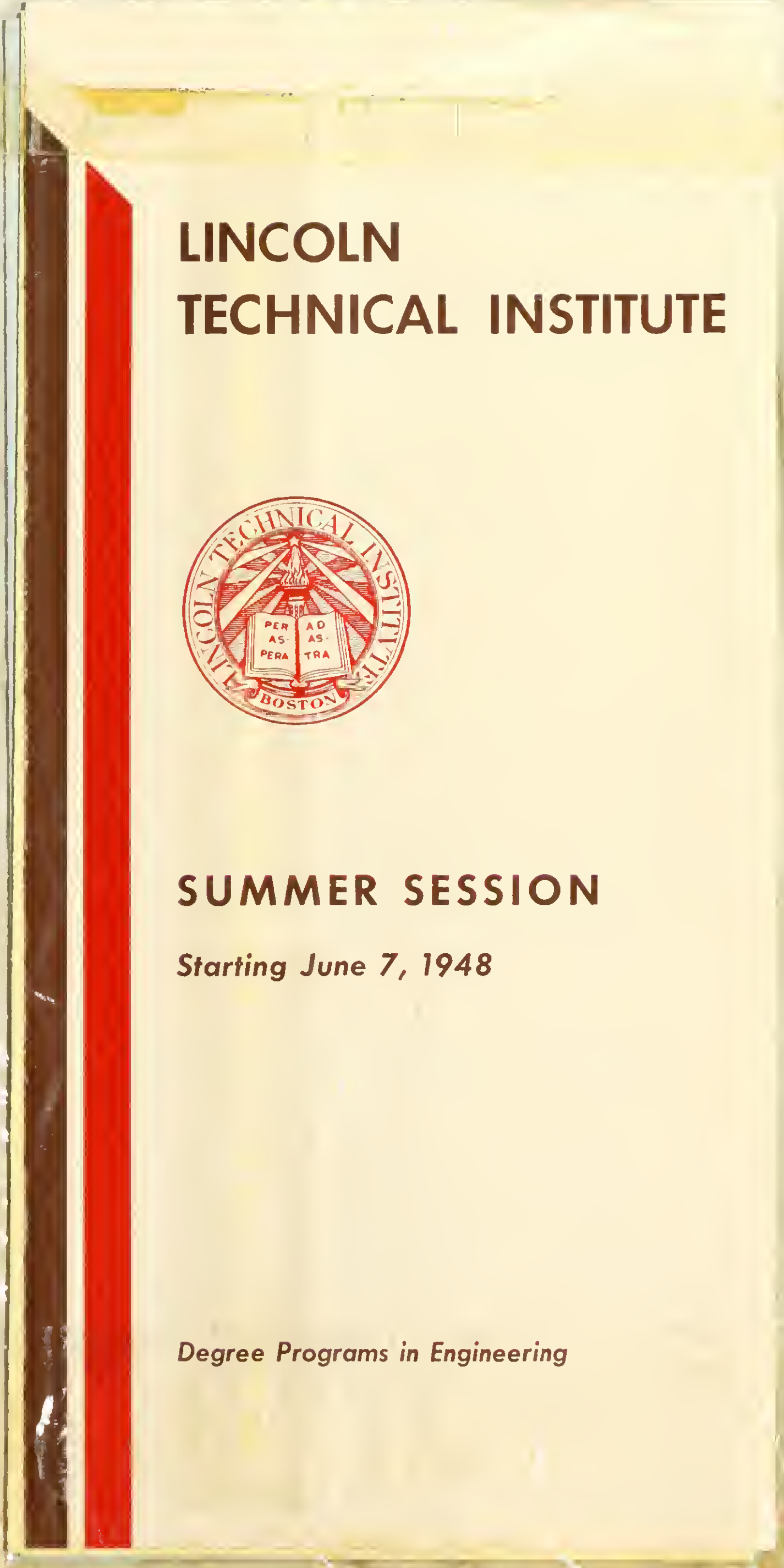
BROCHURE VI

LINCOLN TECHNICAL INSTITUTE



LINCOLN
TECHNICAL INSTITUTE

SUMMER SESSION

Starting June 7, 1948

Degree Programs in Engineering

Evening Degree Programs in Engineering

THE LINCOLN TECHNICAL INSTITUTE

is affiliated with Northeastern University. The Institute offers *Evening Engineering Courses* of college grade leading to the Degree of Associate in Engineering. The classes have full access to the laboratories and facilities of the College of Engineering. These courses have credit toward the degree of Bachelor of Business Administration in Engineering and Management offered by Northeastern University Evening School of Business.

★ VETERANS ★

Qualified veterans are entitled to courses in the LINCOLN TECHNICAL INSTITUTE under the G. I. Bill of Rights (P. L. 346). THE NORTHEASTERN UNIVERSITY VETERANS' COUNSELING CENTER will provide educational and vocational guidance and assist veterans in filing their applications for educational entitlement. *Entitlement covers all costs of tuitions, fees, books and supplies.*

PROGRAMS OF INSTRUCTION

Courses leading to the

DEGREE OF ASSOCIATE IN ENGINEERING

are offered in the following major fields:

CHEMICAL	ELECTRONIC
CIVIL—STRUCTURAL	INDUSTRIAL
ELECTRICAL	MECHANICAL

All courses in these four-year prescribed curricula are of college grade. In those cases where students are unable to carry the normal schedule of three nights per week, a special schedule may be arranged in consultation with the Dean to meet the students' needs and circumstances.

Courses Starting June 7

SUMMER SESSION: JUNE 7-SEPTEMBER 2, 1948

Schedule of Courses

FIRST TERM	SECOND TERM
June 7-July 12 Monday, Wednesday & Friday	July 15-September 2 Monday & Thursday
Direct Current Theory	Alternating Current Theory
Algebra	Trigonometry
Engineering Drawing I	Engineering Drawing II
Physics I	Physics II

All classes meet from 7:00-9:30 p.m.

The courses scheduled above are freshman courses in the degree programs. Students may register in but one course in each term as degree candidates or as special students where specific training is desired to meet individual needs.

ADMISSION REQUIREMENTS

Persons to qualify for registration as degree candidates must be high school graduates having had at least one unit each of Algebra and Plane Geometry. In certain cases, mature persons with a background of work experience but whose education fails to meet the above requirements may be admitted as conditioned students by special arrangements with the Dean and the Committee on Admissions.

TUITION

The charge for each course is $27.50 per term, payable at the beginning of each term.

INTERVIEWS

Prospective students, or those desiring advice or guidance regarding any part of the school work or curricula, are encouraged to arrange for personal interviews with the Dean. Career planning through competent guidance provides an understanding of professional requirements and develops that definiteness of purpose so vital to success.

OFFICE HOURS

The Administration Office is open for general information and registration on the following schedule:

Monday through Friday. . 8:45 A.M. *to* 9:00 P.M.
Saturday . . . . 8:45 A.M. *to* 1:00 P.M.

Personal interviews with the Dean may be arranged by appointment.

★

Address your communications to:

DONALD H. MacKENZIE
Dean

LINCOLN TECHNICAL INSTITUTE
360 Huntington Avenue
Boston 15, Massachusetts
***Telephone*: KENmore 3177**

GENERAL INFORMATION

The Lincoln Preparatory School offers courses throughout the entire year. In addition to the regular classes, which are in session for the normal school year of thirty-two weeks (September through May), there is a Winter Term of twenty weeks (January through May), and a Summer Term of fifteen weeks (June to September).

The diploma of the School is granted to those who have completed fifteen units. Credit is given for work completed in other approved high schools, but in order to secure a diploma a student must complete at least four units of work in the Lincoln Preparatory School.

The office is open daily from 9 a.m. to 9 p.m. except on Saturdays when it is open from 9 a.m. to 1 p.m.

TUITION AND FEES

The cost of each course is $40. The cost of Solid Geometry and Trigonometry if taken separately is $20 each.

Tuition is payable in four installments. The first installment is due on registration and the subsequent payments on November 22, January 31 and March 21.

Fees: Matriculation Fee $5 — non-refundable, except when a student does not satisfy admission requirements. Laboratory fees: Biology $5, Chemistry $5 plus $5 chemistry deposit fee. The unused portion of the deposit fee is refunded after deductions for breakage and non-returnables.

Books and Supplies: Non-veteran students purchase their own books, outlines and other course requirements.

THE LINCOLN PREPARATORY SCHOOL

offers high school courses during convenient evening hours conducted on day school standards. The School is accredited by the New England College Admissions Board.

The courses provide preparation for:

Employment in Business and Industry

Admission to College and Professional Schools (including Nurses' Training in Hospitals)
- By High School Diploma
- By College Entrance Board Examinations
- By Certification (without examination)

VETERANS

Veterans are entitled to courses in the Lincoln Preparatory School under the G. I. Bill of Rights. The Bill provides for all costs of tuition, fees, and required books and supplies.

Veterans may receive counsel and file their Application for Educational Entitlement (Form 1950) thru the NORTHEASTERN UNIVERSITY VETERANS COUNSELING CENTER.

INTERVIEWS

Prospective students, or those desiring advice or guidance regarding any part of the school work, are encouraged to arrange for personal interviews with the principal. Career planning through competent guidance provides an understanding of professional requirements and develops that definiteness of purpose so vital to success.

Address all inquiries to
DONALD H. MacKENZIE, Principal

THE LINCOLN PREPARATORY SCHOOL
360 Huntington Avenue
BOSTON 15, MASSACHUSETTS
Telephone: KEnmore 6-3177

LINCOLN PREPARATORY SCHOOL

Courses Starting Sept. 27

FALL TERM
1948

EVENING SESSIONS

Boston, Massachusetts

LINCOLN PREPARATORY SCHOOL

Accredited by the New England College Admissions Board

EVENING SESSIONS

Fall Term Courses Starting September 27, 1948

COEDUCATIONAL

Schedule of Classes

TUESDAY AND FRIDAY EVENINGS

7 p.m. to 8 p.m.	Algebra 2	Plane Geometry	Algebra 1	English 1	English 3	French 3	Latin 3	Spanish 1	Ancient History	Economics
8 p.m. to 9 p.m.	Plane Geometry	Algebra 2	Algebra 1	English 2	English 4	French 2	Latin 1	Spanish 2	Government	European History
9 p.m. to 10 p.m.	*Trigonometry **Solid Geometry	Algebra 2	Plane Geometry	Problems of Democracy	English 4	French 1	Latin 2	German 1	United States History	English History

Biology	.Meets Thursday	7-10 p.m.	Starting date September 30, 1948
Chemistry	" Wednesday	7-10 p.m.	Starting date September 29, 1948
Physics	" Monday	7-10 p.m.	Starting date September 27, 1948

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* Trigonometry - half course - September 28, 1948 to January 28, 1949

**Solid Geometry - half course - February 1, 1949 to May 20, 1949

Each course is the equivalent of one full unit of high school credit with the exception that four courses in English are the equivalent of three units of credit and that Solid Geometry and Trigonometry are half-unit courses.
A class will be formed in any subject for which a sufficient number of students enroll. The School reserves the right to cancel any course for which there is an insufficient enrollment.

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The diploma of the School is granted to those who have completed fifteen units. Credit is given for work completed in other approved high schools, but in order to secure a diploma a student must complete at least four units of work in the Lincoln Preparatory School.

The office is open daily from 9 a.m. to 9 p.m. except on Saturdays when it is open from 9 a.m. to 1 p.m.

Tuition: Thirty dollars ($30) per course except as follows:

Biology	$40
Chemistry	40
Physics	40
*Solid Geometry	20
*Trigonometry	20

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*Solid Geometry and Trigonometry when taken together cost $30.
Tuition is payable in two installments. The first installment is due on registration and the second payment is due on July 19.

Fees: Matriculation Fee $5 — non-refundable, except when a student does not satisfy admission requirements. Laboratory fees: Biology $5, Chemistry $5 plus $5 chemistry deposit fee. The unused portion of the deposit fee is refunded after deductions for breakage and non-returnables.

Books and Supplies: Non-veteran students purchase their own books, outlines and other course requirements.

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Telephone: KEnmore 6-3177

LINCOLN PREPARATORY SCHOOL

Courses Starting June 3

SUMMER TERM
1948

EVENING SESSIONS

Boston, Massachusetts

LINCOLN PREPARATORY SCHOOL

Accredited by the New England College Admissions Board

EVENING SESSIONS

Summer Term Courses Starting June 3, 1948

COEDUCATIONAL

Schedule of Classes

MONDAY AND THURSDAY EVENINGS — JUNE 3 TO SEPTEMBER 16

7:00 p.m. *to* **8:30** p.m.	Algebra 1	Algebra 2	English 2	English 3	French 1	Latin 2	Economics	United States History
8:30 p.m. *to* **10:00** p.m.	Plane Geometry	*Trigonometry 8:30-9:15 *Solid Geometry 9:15-10:00	English 1	English 4	French 2	Latin 1	Government	European History

MONDAY, WEDNESDAY AND FRIDAY EVENINGS — JUNE 4 TO JULY 2
THEN
MONDAY AND THURSDAY EVENINGS — JULY 8 TO SEPTEMBER 2

7:00 p.m. *to* **10:00** p.m.	Biology	Chemistry	Physics

Each course is the equivalent of one full unit of high school credit with the exception that four courses in English are the equivalent of three units of credit and that Solid Geometry and Trigonometry are half-unit courses.
A class will be formed in any subject for which a sufficient number of students enroll. The School reserves the right to cancel any course for which there is an insufficient enrollment.

BROCHURE VII

Use Your Universities

COLLEGE STUDY AT HOME

University of Florida

Florida State University

COLLEGE STUDY AT HOME

Offered Through

GENERAL EXTENSION DIVISION

Seagle Building

Gainesville, Florida

GENERAL INFORMATION

The University of Florida and Florida State University through the General Extension Division offer to any Floridian, wherever his home, many of the courses available to students in residence.

The curricula of the two Universities are not restricted to those fortunate enough to be able to attend at Gainesville or Tallahassee. Through home study, courses are open to all who may profit from them.

This bulletin contains, in question and answer form, an explanation of how home study may be pursued.

What is College Correspondence or Home Study as Offered by the University of Florida and Florida State University?

College Correspondence study is a method of home study by which those who must suspend formal education may continue with their studies. The courses offered include those for which credit is given toward degrees, subject to conditions explained elsewhere in this bulletin.

These courses are offered particularly for (1) public school teachers who wish to work toward degrees or otherwise to advance themselves professionally, (2) others who desire to improve the quality of their work and to qualify themselves for the job ahead, or who wish simply to expand their knowledge in a variety of fields, (3) prospective college students or those college students who, having to interrupt their courses in residence, wish to avoid loss of time.

How Does It Work?

Each course is based on a study guide, consisting of an introduction which gives the student pertinent information concerning textbooks, materials, and a general outline of the course; a series of assignments, varying in number according to the course, which students must complete and return to the General Extension Division for correction and grading by members of the faculties of the state universities; and a final examination which must be taken in accordance with regulations which will be transmitted to the student at the time of completion of assignments.

To get most out of a course, the instructions in the study guide should be followed closely. These instructions have been evolved over a period of years and have been proved again and again.

Who May Enroll?

Anyone who feels he is qualified by education, training, or experience to profit from college level courses, is eligible to enroll.

To obtain college credit, however, it is necessary that an applicant for enrollment be eligible for admission to institutions of higher learning.

While the courses are designed particularly to fit into the curricula of the University of Florida and Florida State University, leading toward degrees, many of them have been found valuable to men and women in business and professional fields, to men and women interested in civic and social affairs, to men and women anxious to increase their understanding of political and economic problems. It should be borne in mind that these courses are on the college level and that some educational preparation is essential for successful completion.

What Credit Is Offered?

College credit is given for successful completion of correspondence study courses. Each course description indicates the number of semester—or quarter hours—which may be earned. Before credit earned by correspondence can be applied toward a degree, the student must have complied with all entrance requirements and all regulations governing the degree toward which correspondence study is to be applied.

> Note: A student contemplating courses to be applied toward a degree should, before enrolling, consult the dean of his college so as to be sure these courses meet requirements.

How Much Work is Involved in a Correspondence Study Course?

For each semester hour, the standard requirement is eight written assignments—for each quarter hour, six written assignments. For example, a three semester hour course at the University of Florida requires the completion of 24 written assignments; a three quarter hour course at Florida State University requires 18 written assignments. It is not possible to vary the number of assignments nor the credit allotted to a course to meet the needs or desires of the student. All assignments must be completed and an examination passed before credit will be given in any course.

How May One Enroll?

Students may enroll for correspondence work at any time except that when in residence at an institution of higher learning, permission of that institution must be obtained. The following instructions must be observed:

(1) Complete the registration blank which will accompany this catalog of courses and submit it to the Correspondence Study Department, General Extension Division, Seagle Building, Gainesville, Florida. Application may be made for no more than two courses at a time.

(2) State both name and number of course desired, previous work taken in the field, and degree toward which credit is to be applied. This latter requirement does not apply to students who are not studying for college credit.

(3) Enclose the course fee with the application. If, for any reason, enrollment is not accepted, the fee will be returned.

How Fast May Courses Be Completed?

No more than three assignments per week may be submitted, unless there is imperative need for haste, in which case, with special permission, a student may complete one assignment per day—six per week. By moving slowly, the student has the opportunity to profit from comments and suggestions of the instructor as completed assignments are returned.

What Does It Cost?

For Florida residents, the fee for any college course is $5.00 per semester hour—$3.75 per quarter hour—payable at time of application. For example, a three semester hour course will cost $15.00 For non-residents the fee is $6.00 per semester hour and $4.75 per quarter hour. Remittance should be made payable to the General Extension Division.

The above fees do not include textbooks or other materials. Cost of these will be contained in the preliminary statement which may be obtained on request from the Correspondence Study Department.

> Note: Students must select courses carefully and definitely before enrolling, since no refund is allowable. Transfer from one course to another is permitted in accordance with regulations contained elsewhere in this bulletin.

Where May Textbooks Be Obtained?

Textbooks must be obtained by the student. They may be purchased from the University Bookstore, University of Florida, Gainesville, from a local bookstore, or through the publisher as explained in the course introduction. Used books sometimes are available from the University Bookstore at reduced prices. It is best to send remittances covering new books at list price, to the Bookstore; if used books are preferred and are available, the Bookstore will refund the difference in cost; unless used books are requested, new books will be supplied.

Communications and remittances for textbooks should be sent direct to the University Bookstore, since the General Extension Division cannot undertake to handle them.

What Reference Materials Are Necessary and Where May These Be Obtained?

Extent of reference materials required varies with the course. Frequently, these are readily available in municipal libraries. If not, they may be borrowed from the General Extension Division Library. It is advisable to look through advance assignments for reference materials necessary so that they may be borrowed from the Division Library in plenty of time. The only expense of borrowing from this Library is cost of transportation of books or other materials. The loan period on all General Extension Division Library reference materials is two weeks.

How Are Courses Graded?

Grading is by letter symbols—A, B, C, D, E, and R. D is the lowest passing grade. E is failure; R (condition) is failure with privilege of re-examination.

How Are Final Examinations Taken?

Supervised final examinations will be given in accordance with instructions which will be mailed to each student individually when he nears completion of the course. The grade on the final examination weighs heavily on the final grade for the course.

Caution—

1. The only way instructors can measure progress or be aware of difficulties of students is from the written assignments submitted. There is no objection to two or more students discussing assignments. When the lessons are submitted for grading, however, they must contain every evidence of being the sole work of the student submitting them. Assignments which do not conform to this requirement will not be graded.

2. Each student must assume full responsibility for registering for proper courses. Before registering, the student working for college credit should confer with the dean of his college regarding choice of courses.

3. Students who are working toward deadlines—as for example, those who must complete a course by a certain date to obtain certification or who need a course in their record before enrolling for a term in residence—should plan their work so that the final examination is completed at least 30 days prior to that deadline in order that recording of grades and transmission of the record can be concluded in adequate time.

Regulations—

1. One assignment per day—six per week—is the maximum speed at which a student will be permitted to work.

2. All assignments must be submitted on correspondence study paper, obtainable from the University Bookstore, University of Florida, Gainesville, Florida.

3. No more than 12 semester hours—18 quarter hours—may be taken by extension during an academic year; no more than nine semester—13 quarter—hours may be taken during a summer vacation period.

4. No more than 12 semester hours—18 quarter hours—may be taken by extension in any one field for application toward meeting degree requirements.

5. The last 30 hours toward a degree must be taken in residence, except that 12 of the last 36 hours of work toward a degree in the College of Education and College of Physical Education, Health and Athletics may be earned by Extension. Any deviation from this must be sanctioned by the faculty of the college concerned.

6. Under no circumstances will a student in residence at the University of Florida be permitted to take by correspondence a course which is being offered in residence.

7. A student who is enrolled in any institution may take correspondence courses only with the written permission of his dean.

8. No more than 25 per cent of the hours required for a degree may be earned by extension.

> Note: This rule does not prohibit teachers from taking additional work to add subjects to their certificates, for extension of certificates, for increasing professional proficiency, or for cultural advancement.

9. Graduate work is not offered by correspondence study. Graduate students may however, take undergraduate courses to make up deficiencies in major or minor fields.

10. A period of one year is allowed for completion of a course.

11. A student may transfer from one correspondence course to another giving equal credit upon payment of 50 cents for each assignment sub-

mitted in the first course. Courses cannot be transferred from one student to another.

12. Students dropped for failure in residence studies may not enroll.

13. Students under suspension from the University of Florida or Florida State University may not enroll for correspondence work until the period of suspension is over.

14. No refunds of enrollment fees will be made. These fees are immediately remitted to the state treasurer and therefore refunds are impossible.

Note: Extension work includes study both in extension classes and by correspondence.

Other Educational Opportunities—

In addition to offering correspondence study courses, the General Extension Division, with the cooperation of the colleges of the University of Florida and the Florida State University, develops educational programs presented in workshops, extension classes, short courses, institutes, conferences and film forums to meet specific needs. Groups interested should address inquiries to the Dean, General Extension Division, Seagle Building, Gainesville, Florida.

UNIVERSITY OF FLORIDA

COURSES

Brief descriptions of courses, arranged according to subject matter, follow. The number is the same as the equivalent course given in residence at the University of Florida.

ACCOUNTING

Atg. 211. Elementary Accounting. Designed to provide the basic training in business practice and in accounting. A study of business papers and records; recording transactions; preparation of financial statements and reports. Prerequisite for advanced standing in Economics and Business Administration. 3 semester hours.

Atg. 212. Elementary Accounting. A continuation of Atg. 211. Atg. 211-212 are equivalent to Introductory Accounting 201-202-203 at the Florida State University. 3 semester hours.

Atg. 311. Accounting Principles. Prerequisite: Elementary Accounting. A study of the mechanical and statistical aspects of accounting; books of record; accounts; fiscal period and adjustments; working papers; form and preparation of financial statements, followed by an intensive and critical study of the problems of valuation as they affect the preparation of the balance sheet and income statements. 3 semester hours.

Atg. 312. Accounting Principles. Prerequisite: Atg 311. Consideration is given to the legal aspects of accounting and related problems resulting from the legal organization form used by businesses: liabilities; partnerships; corporations; capital stock; surplus; followed by a study of the financial aspects of accounting as disclosed by an analysis and interpretation of financial statements; financial ratios and standards, their preparation, meaning and use. 3 semester hours.

AGRICULTURE

Agronomy

Ay. 321. Field Crops. A general survey of the leading farm crops, including characteristics, adaptations, fertility requirements, cultural practices, rotation systems and uses of the more important field crops. 3 semester hours.

Animal Production

Al. 411. Beef Production. Prerequisite: Al. 409. Selection, feeding, and management of beef cattle; finishing and marketing. 2 semester hours.

Al. 413. Swine Production. Prerequisite: Al. 409. Selection, feeding, and management of hogs; forage crops and grazing; nitrogenous supplements; disease and parasite control; slaughtering and marketing. 3 semester hours.

Poultry Husbandry

Py. 301. Fundamentals in Poultry Production. Breeds and varieties; location and construction of buildings; feeding and management; incubation; breeding; marketing; brooding; rearing pullets; managing layers. 3 semester hours.

Py. 415. Poultry Management. Prerequisite: Py. 301 for Agricultural College Students; no prerequisite for non-credit students. Large farms; equipment of poultry plants; planning of various buildings; poultry farm plans; management of laying enterprise; cost and returns in producing eggs; capital. 3 semester hours.

Py. 416. Poultry Management. Prerequisite: Py 301 for Agricultural College students; no prerequisite for non-credit students. (a) Hatching Industry: location; business side of hatchery management; cost of producing chicks, factors affecting cost of production; investment. (b) Broiler Production: breeds; equipment and design of broiler plants; management of broilers; costs and returns of broiler production; factors affecting cost of production; investment. 3 semester hours.

Horticulture

He. 310. Plant Pruning. Principles and practices in the pruning of trees and shrubs and in the treatment of wounds and cavities. Equivalent to the resident course of the same number, except the laboratory exercises. 2 semester hours.

He. 312. Vegetable Gardening. Origin, relationship, classification of truck crops; varieties, cultural methods, fertilizing, irrigating, harvesting. Planning the home garden. Florida conditions are emphasized. The laboratory work of the residence course should be taken when the student attends the University to make up the additional hour of credit. 2 semester hours.

He. 314. Principles of Fruit Production. A general introductory course in the theory and practice of fruit growing. Principles underlying fruit production, such as water relations, nutrition, temperature, fruit setting, and geographic influences. 3 semester hours.

He. 427. Elementary Floriculture. The principles of flower culture, with special emphasis on the growing of annuals and perennials for the home garden. This course is equivalent to the residence course of the same number, except that the field laboratory exercises are not included. 2 semester hours.

He. 428. Commercial Floriculture. The propagation and handling of commercial florist's crops and the management of greenhouses. This course is equivalent to the residence course of the same number, except that it does not include the laboratory work. 2 semester hours.

Soils

Sls. 301. Soils. Prerequisite: General or Agricultural Chemistry. The nature and properties of soils with elementary treatment of genesis, morphology, and classification. Soil types and problems in Florida. Description, identification and mapping of Florida soils. One hour of laboratory work for this course must be taken in residence. 2 semester hours.

Sls. 302. Soil Fertility. Prerequisite: Sls. 301. General principles of soil fertility. The physical, chemical, and biological factors affecting soil fertility and crop production. Studies on samples of soil from the home farm; commercial fertilizers, manures, green manures and organic matter maintenance, crop rotations and permanent soil fertility. One hour of laboratory work to be taken in residence. 2 semester hours.

BUSINESS EDUCATION

BEn. 97. Handwriting. A course which combines the teaching of both cursive and manuscript writing with practice work in both types. Methods of teaching handwriting in each of the elementary grades. 1 semester hour.

ECONOMICS AND BUSINESS ADMINISTRATION

Es. 203. Elementary Statistics. The statistical method as a tool for examining and interpreting data; acquaintance with such fundamental techniques as find application in business, economics, psychology, sociology, etc.; basic preparation for more extensive work in the field of statistics. Prerequisite for advanced standing in Economics and Business Administration. 3 semester hours.

Es. 205. Economic Foundations of Modern Life. A course in principles of economics equivalent to Principles of Economics 201 at the Florida State University. Emphasis on the fuctioning of the economic system. Economic organization and institutions as parts of the economic order in their functional capacities. The evaluation of economic forces and processes in terms of their contribution to social well being. Prerequisite for advanced standing in Economics and Business Administration. 3 semester hours.

Es. 206. Economic Foundations of Modern Life. Continuation of Es. 205. Equivalent to Principles of Economics 202 at the Florida State University. 3 semester hours.

Bs. 361. Property Insurance—Fire and Marine Insurance. The primary purpose of this course is to give instruction in the broad, basic principles underlying the science and business of Fire and Marine Insurance. Not primarily a course in insurance salesmanship, but nevertheless a course which should be of value to persons engaged in this business. 3 semester hours.

Bs. 362. Property Insurance. A continuation of Bs. 361 dealing with bond, title, and casualty insurance. 3 semester hours.

Bs. 401. Business Law. Contracts and agency; the formation, operation, interpretation, and discharge of binding agreements; creation of the relation of agents; rights and obligations of the agent, principal, and third party; termination of the relationship of agency. 3 semester hours.

Bs. 402. Advanced Business Law. Conveyances and mortgages of real property; sales and mortgages of personal property; the law of negotiable instruments; partnership. 3 semester hours.

Bs. 461. Principles of Life Insurance. The functions and nature of life insurance; the economic characteristics of life insurance; the fundamentals of the science of life insurance; practices and policies of insurance companies; types of insurance companies. 3 semester hours.

Real Estate Principles, Practices and Procedures. A course intended to aid those who have just entered—or who are about to enter—the real estate business as real estate salesmen or prospective real estate brokers. The purpose of this course is to instruct the beginner in some of the legal, economic and technical aspects of the business and to lay the foundation necessary for specialization in other real estate course studies. An attempt is made to guide the beginner to a comprehensive view of the real estate business. The course will deal with the brokerage business in general and with Florida brokerage practices and procedures in particular. No credit. Fee $15.00.

EDUCATION

En. 241. Introduction to Education. Principles upon which present day education is based. 3 semester hours.

En. 303. Methods of Teaching Vocational Agriculture. The organization of a long-time teaching program; selection of proper equipment and the arrangement of the classroom and farm shop; organization of all-day, day-unit, part-time and evening classes and methods employed in teaching these various groups. 3 semester hours.

En. 305. Development and Organization of Education. An attempt to interpret and evaluate the role of the public school in our rapidly changing society. This course makes a searching study into the past in the attempt to give us insight into the work of the day. It emphasizes relationships and understandings rather than dates and names. 3 semester hours.

En. 306. Vocational Education. Development, function, and scope of vocational, agricultural, home economics, trade and industrial, and commercial education as provided for by the National Vocational Education Act of Congress. 3 semester hours.

En. 316. Elementary Quantitative Methods in Education and Psychology. Application of statistical processes and formulas to educational and psychological data are studied. Stress is laid on the interpretation of typical quantitative treatments of findings in psychology and education. 3 semester hours.

En. 385. Child Development. Designed to acquaint the student with the growth and development of children into mature personalities. The fiindings of recent research will be studied through outside reading and observation. Methods of evaluation of child growth will be included. 3 semester hours.

En. 386. Educational Psychology. The individual and education. A study will be made of the physical, emotional, mental, and social growth of the adolescent. Achievement will be considered in terms of growth. The learning process. 3 semester hours.

En. 397. Secondary School Curriculum and Instruction. The Curriculum and instruction. The study of a group of children, planning a program for the group, and setting up a system of evaluation. 3 semester hours.

En. 406. Administration of the Elementary School. This course will give credit which may be used toward meeting the requirements for a Florida Certificate in Administration and Supervision. While it is designed primarily to throw light on the administrative problems facing the Elementary Principal, it should also be of interest to teachers who desire a broader concept of the general purposes of the elementary school. 3 semester houurs.

En. 408. High School Administration. This course is designed to study the practical management and administration of the modern high school. It will consider such topics as: duties of principal as head of school; relation of principal to board of education, superintendent, teachers, pupils, and community; legal status of the high school; systems of financing; selection, supervision, promotion, retention and dismissal of teachers, adjustment of teaching load; testing and grading of pupils; problem of discipline; pupil guidance, athletics, wider use of the school plant, supervised study, student activities, teachers' meetings, etc. 3 semester hours.

ENGINEERING

Electrical Engineering

El. 341. Elements of Electrical Engineering. Prerequisite: Physics and Calculus. Electric and magnetic circuits, electrostatics; electromagnetics; representation of alternating currents by vectors and complex quantities; measurement of power in single phase and polyphase circuits; generation, transmission, and utilization of electrical energy; characteristics of apparatus; selection, testing, and installation of electrical equipment. 3 semester hours.

El. 342. Elements of Electrical Engineering. Continuation of El. 341. 3 semester hours.

El. 344. Problems in Direct and Alternating Currents. Corequisite: El. 342. Electrostatics, energy and power, wave form, power in single and polyphase circuits, unbalanced circuits, harmonics. 3 semester hours.

Industrial Engineering

Ig. 365. Engineering Mechanics—Statics. Prerequisites: Ps. 211, Ms. 353, Ml. 182. Principles of statics; resolution and equilibrium of concurrent forces; numerical and graphical solution of trusses and hinged frames; couples; centers of gravity; forces in space; and moments of inertia. 3 semester hours.

Ig. 366. Engineering Mechanics—Dynamics. Prerequisite: Ig. 365. Principles of dynamics; rectilinear, curvilinear, and harmonic motions; momentum and impulse; work and energy; force, mass, and acceleration; projectiles; simple, torsional, and compound pendulums; balancing of rigid bodies; and relative motion. 3 semester hours.

Ig 367. Engineering Mechanics—Strength of Materials. Prerequisite: Ig. 365. Tension, compression, shear, stress and strain; combined stresses;

riveted joints for pressure vessels and structural work; torsion, bending moments; stresses and deflection of simple, cantilever, and continuous beams; concrete beams; curved beams and hooks; eccentric loading columns; and elastic strain energy. 3 semester hours.

Ig. 463. Specifications, Engineering Relations, and Industrial Safety. Prerequisite: Senior Classification. Specifications for materials and construction of engineering projects; advertising and lettering contracts; agreements and contractual relations. Organization for safety work in industry, accident causes and legal responsibility of employer and employee. 3 semester hours.

Ig. 472. Human Engineering. Prerequisite: Ig. 463. A study of some of the problems of production engineering and certain questions of personnel management. The human factors in industry. 2 semester hours.

Mechanical Engineering

Ml. 181. Engineering Drawing. The foundation course in mechanical drawing essential for all engineering students. Designed to teach the student how to make and read engineering drawings. 2 semester hours.

Ml. 182. Descriptive Geometry. Prerequisite: Ml. 181. A course in drawing board geometry dealing with the principles of projection and the development of surfaces. 2 semester hours.

ENGLISH

Eh. 217. Literary Masters of England. The most interesting and significant English writers are read and discussed, primarily for an appreciation of their art and outlook on life. English majors should elect this course the Sophomore year. 3 semester hours.

Eh. 218. Literary Masters of England. A continuation of Eh. 217, by which it should be preceded, to complete the year's work in Sophomore English literature. 3 semester hours.

Eh. 223. Masterpieces of World Literature. The object of this course is to furnish the student with some general idea of world literature, both as desirable in itself and as necessary to the more detailed study of English and American literary history. The first semester will deal with the literature of antiquity through that of ancient Greece. 3 semester hours.

Eh. 224. Masterpieces of World Literature. A continuation of Eh. 223. This course will begin with Roman literature and cover medieval literature to the Renaissance. 3 semester hours.

Eh. 306. Modern English Grammar. Study of modern English inflection and syntax. The course is designed to be of practical value to teachers of English, and is intended especially for students in the College of Education majoring in English. 3 semester hours.

Eh. 355. Business Writing. The purpose of this course is to prepare persons who intend to enter business to conduct their correspondence more successfully; and to improve the technique of those engaged in teaching English and commercial subjects. 3 semester hours.

Eh. 363. Contemporary Literature: Drama. A study of recent and contemporary drama, with emphasis upon such major English and American playwrights as Shaw and Eugene O'Neill. The work of Ibsen and other Continental writers will be treated briefly. 3 semester hours.

Eh. 365. Contemporary Literature: Fiction. The purpose of this course is two-fold: first, to give the student a general view of the development of the English novel during the past sixty years; second, to study some fundamentals of the technique of the novel, with the idea of developing a basis for more intelligent criticism and appraisal of modern fiction. 3 semester hours.

Eh. 366. Contemporary Literature: Poetry. This course is intended to help the student's understanding of modern poetry in three ways: (1) the first assignments are in the work of poets who are clearly in the tradition of English verse as the student has learned to know it through previous courses. (2) Special emphasis is laid upon those poets who have been most influential in the shaping of modern verse, those who have been most widely imitated and adapted by others. (3) Some work is assigned in very recent verse with the notion of acquainting the student with quite recent trends. 3 semester hours.

Eh. 391. Children's Literature. Designed to arouse and satisfy a genuine interest in children's books apart from school textbooks, to aid the student to obtain a better working knowledge of this literature, and to make him more aware of degrees of excellence in content and form. 3 semester hours.

FORESTRY

Fy. 220. Introduction to Forestry. This is an orientation course in forestry, covering the entire field. It is intended for agricultural high school and other teachers, county agents, supervisors of 4-H projects, as well as forest owners and users, or persons expecting to take up Forestry. It also gives a general view of forestry to persons interested in vocational guidance. 2 semester hours.

Fy. 306. Forest Protection. Technique of forest fire protection, as developed and practiced in the United States with special emphasis on the Southern States. 2 semester hours.

Fy. 318. Forest Utilization and Products. This course covers the manufacture and use of forest products other than logging and lumbering. It reviews the following divisions of forest industry: Naval stores, poles and piling, cross-ties, paper and pulp, boxes and crates, wood distillation, veneers and plywood, mine timbers, etc. This course is required for forestry degree. It is also designed for forest land owners and manufacturers of forest products. It furnishes a general view of wood uses and markets. 3 semester hours.

Fy. 410. Forest History and Policy. Available only to students who have access to Forestry library on campus. Study of all factors affecting the forests of the United States from colonial days to the present. Rise of a conservation sentiment, with special emphasis on laws relating to forests. Development of the United States Forest Service and the National Forests. Influence of the National Forests and other forces upon our forest policy. Recent Federal Laws relating to forest land acquisition and forest experiment stations. 2 semester hours.

HISTORY

Hy. 301. American History, 1492 to 1776. The purpose of this course is to familiarize students with the history of America and of American institutions. Beginning with the period of discovery and colonization, a detailed study is made of each colony. The Revolutionary movement, the period of the Articles of Confederation, the adoption of the Federal Constitution, and the social, political, and economic development of the United States up to 1830 are subjected to close analysis. 3 semester hours.

Hy. 302. American History, 1776 to 1830. A continuation of Hy. 301, completing the year's work. The early Constitutional Period. 3 semester hours.

Hy. 303. American History, 1830 to 1876. The background and causes of the War Between the States, the rise and fall of the Confederacy, and the Reconstruction Period. 3 semester hours.

Hy. 304. American History, 1876 to 1945. A continuation of Hy. 303, by which it must be preceded. The political, social, economic, and cultural development of the United States after 1876. Special emphasis is placed on our international relations. 3 semester hours.

Hy. 331. Survey of American History. Prerequisite: C-1 and Hy. 214 or Hy. 313-314. The first half of the course Hy. 331-332. A general survey course on the development of the United States to 1830. 3 semester hours.

Hy. 332. Survey of American History. The second half of the course Hy. 331-332, covering the period from 1830 to the present. 3 semester hours.

MATHEMATICS

***Ms. 105. Basic Mathematics.** In place of the traditional college algebra, trigonometry, and analytic geometry in succession, this course offers a completely new sequence of topics including much of the foregoing plus a liberal amount of calculus. Thus the student will obtain early a working knowledge of such mathematics as is basic to the study of the sciences and other subjects and needed for the cultivation of habits productive of clear thinking, writing, and speaking. Moreover, the choice of material is so made as to present mathematics as an integrated whole, and at the same time to show its correlation with other subjects in the curriculum. 4 semester hours.

***Ms. 106. Basic Mathematics.** A continuation of Ms. 105 by which it must be preceded. 4 semester hours.

Ms. 226. Algebra for Teachers. The materials of first and second year high school algebra. A study of the State adopted text with supplementary and illustrative material. Methods of presentation. Functional relationships. Construction and interpretation of graphs. 3 semester hours.

Ms. 308. Business Methematics. Some of the topics treated are the theory of compound interest, and the application of algebra to the solution of problems in annuities, depreciation of assets, payment of debts by periodic installments, purchase price of bonds, capitalized cost of a plant. 3 semester hours.

Ms. 311. Advanced College Algebra. Prerequisite: A good knowledge of advanced high school algebra. The further treatment of some of the material and processes of second year high school algebra and the introduction to more advanced topics. 3 semester hours.

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* Basic Mathematics Ms. 105-106, in general, should be attempted only by superior students with four years of high school mathematics.

Ms. 325. Advanced General Mathematics. (Especially designed for high school teachers.) Selected topics having a direct and significant bearing upon the teaching of mathematics in high school. Consideration of the subject matter itself and its relation to adequate reorganization programs, both in the light of general modern objectives and experience obtained in the teaching of mathematics in the General College. This course is concerned with the teaching of general (practical) mathematics and algebra in high schools. 3 semester hours.

Ms. 326. Advanced General Mathematics. (Especially designed for high school teachers.) This course deals with the teaching of geometry and trigonometry. May precede or follow Ms. 325. 3 semester hours.

Ms. 353. Differential and Integral Calculus. Prerequisite: Ms. 105-106 or equivalent. Differentiations and integration. Typical problems solved by these methods are calculation of rates of change, computation of areas, volumes, moments of inertia, energy, power, and many others. Various advanced topics of special value to engineers and scientists. 4 semester hours.

Ms. 354. Differential and Integral Calculus. A continuation of Ms. 353, by which it must be preceded. 4 semester hours.

Ms. 420. Differential Equations. Prerequisites: Ms. 353-354. The classification, solution, and application of various equations which contain expressions involving not only variables, but also the derivatives of these variables. 3 semester hours.

MODERN LANGUAGES

French

Fh. 201. Second Year French. Prerequisite: One year of College French, or two years of high school French. Readings from modern French writers. 3 semester hours.

Fh. 202. Second Year French. The second half of French 201-202. 3 semester hours.

German

Gn. 201. Second Year German. Prerequisite: German 33-34 or equivalent. Reading of modern stories and dramas. 3 semester hours.

Gn. 202. Second Year German. The second half of the course German 201-202. 3 semester hours.

Spanish

Sh. 201. Second Year Spanish. Prerequisite: Spanish 33-34 or equivalent. Readings in representative Spanish and Latin-American literature of moderate difficulty. 3 semester hours.

Sh. 202. Second Year Spanish. The second half of the course Sh. 201-202. 3 semester hours.

PHILOSOPHY

Ppy. 409. Ancient Philosophy. The development of philosophic thought from its appearance among the Ionic Greeks to the time of Descartes. 3 semester hours.

Ppy. 410. Modern Philosophy. A continuation of Ppy. 409. Special attention is given to the works of Descartes, Spinoza, Leibnitz, Hume, and Kant. 3 semester hours.

PHYSICS

Ps. 101. General Physics. This course fulfills the first half of the requirements for the theoretical course in general college physics for all students except those who are intending to major in physics in the College of Arts and Sciences or for those who are in the College of Engineering. The course does not provide for any laboratory work, hence any student whose course of study requires laboratory work in physics will find it necessary to take such work in residence. 3 semester hours.

Ps. 102. General Physics. This course fulfills the requirements for the second half of the general course in college physics, subject to the same conditions as specified under Ps. 101. 3 semester hours.

Ps. 292. Meteorology. Prerequisite: C-2. A brief general course designed to give the student an insight into the physical processes and laws underlying the phenomena of weather and climate. It is to satisfy the interested curiosity of the general student as well as to furnish a foundation for further study on the part of those, such as aviation students, who are interested from a practical standpoint. 3 semester hours.

POLITICAL SCIENCE

Pcl. 313. American Government and Politics. The first half of the course Pcl. 313-314. A study of the structure and functions of our national and state governments. Present day political problems of national and local interest will be discussed. This course is a prerequisite for other courses in Political Science, and for students who do not enter the Upper Division of the University from the University College. 3 semester hours.

Pcl. 314. American Government and Politics. The second half of the course Pcl. 313-314. An outline of the growth of American municipalities and a study of the organs and functional mechanism of modern cities of the United States and Europe. Emphasis is laid upon the newer tendencies in municipal government, including the commission form and city manager plan. 3 semester hours.

PSYCHOLOGY

Psy. 201. General Psychology. An elementary treatment of the general topics in the field of Psychology. Designed to provide an understanding of human behavior, approached as a natural phenomenon subject to scientific study. The unifying concept of the course is the adaptation of the individual to his physical and social environment. 3 semester hours.

Psy. 305. Social Psychology. Influence of the social environment upon the mental, social, moral, and emotional development of the child, the adolescent and the adult. General orientation, typical and atypical forms of behavior, social stimulations and responses, social attitudes, social adjustments, language development, personality development, and social changes. 3 semester hours.

Psy. 309. Personality Development. A study of the mechanisms of personality formation, with special emphasis upon the varieties of human adjustment. The more inevitable problems of human life with their normal and abnormal solutions. The origin and modification of behavior. Processes of motivation and adjustment. Development and measurement of personality traits. Techniques of mental hygiene. 3 semester hours.

Psy. 312. Psychology of Exceptional Children. Prerequisite: Psy. 201. Individual differences, intelligence, feeble-mindedness, dull and backward children, superior and gifted children, speech and motor defects, sensory and neurological disorders, conduct problems, social and emotional maladjustments, and other topics concerning exceptional and mentally peculiar children. 3 semester hours.

Psy. 314. History and Systems of Psychology. A critical survey of the historical development of psychology from the early Greek period, with special emphasis on the contribution of the Germans, the French, the English, and such representative writers as Aristotle, Descartes, Hobbes, Locke, the Mills, Fechner, Wundt, Binet, James and many others. The more recent trends, schools, and systems as Structuralism, Functionalism, Behaviorism, and Gestalt Psychology. 3 semester hours.

Psy. 410. Abnormal Psychology. A study of the abnormal phases of mental life and the ways in which the individual develops abnormal habits of thinking and acting. A survey of the signs of beginning maladjustment and procedures which should be followed to correct these tendencies. Special suggestions are given for the prevention and treatment of mental disease. 3 semester hours.

SOCIAL STUDIES

Scl. 301. Children's Social Studies. A opportunity will be given to study content material in the social studies field with implications for the activity program. 3 semester hours.

Scl. 302. Children's Social Studies. A continuaton of Scl. 301. 3 semester hours.

WATER AND SEWAGE TREATMENT

(These courses open only to water and sewage plant operators)

Elements of Chemistry. A course prepared especially to provide water plant operators with a working knowledge of the fundamental laws and principles of chemistry as applied to the various steps in water treatment. Non-credit. Fee $10.00.

Pumps. A practical treatment of pumps: types available, method of selection of proper type for a given job, method of installation, operation and "trouble shooting", and maintenance. Non-credit. Fee $10.00.

FLORIDA STATE UNIVERSITY

COURSES

Brief descriptions of courses, arranged according to subject, follow. The number is the same as the equivalent course given in residence at the Florida State University.

COMMERCE

305. Elementary Cost Accounting. Prerequisite: Accounting 201-202-203. Principles and methods of costing products manufactured, by Job Cost System and Process System. Production Order Practice Set. Accounting for joint products, by-products, and waste. 5 quarter hours.

405. Income Tax Accounting. Prerequisite: Accounting 201-202-203. Federal Income Tax preparation of returns for individuals, partners, fiduciaries, and corporations. Administrative provisions, penalties for violation. Estate tax. Gift tax. 5 quarter hours.

EDUCATION

336. **Principles Underlying the Teaching of Reading.** Prerequisite: Education 305. Not open to freshmen. A survey will be made of the various procedures followed in the teaching of reading, with an attempt to evaluate them. 4 quarter hours.

345. **Pre-School Education.** Prerequisite: Education 305 and nine quarter hours of psychology. A comprehensive treatment of the important educational problems and agencies concerned with the education of the young child. 4 quarter hours.

428. **History of Education in the United States.** This course aims to trace, describe, and evaluate, in the light of accepted facts, the development and growth of our educational practice, institutions, and theories from the beginning of colonial life to the present time. Open to juniors and seniors only. 4 quarter hours.

ENGLISH

101. **Composition.** The principle aims of this course are clear thinking, correct and easy expression in writing and speaking, intelligent reading. Some training in the methods of study and work commonly used in the more advanced courses. 3 quarter hours.

102. **Composition.** A continuation of English 101, by which it must be preceded. 3 quarter hours.

103. **Composition.** A continuation of English 102 and must be preceded by English 101 and 102. This completed sequence is prerequisite to all following English courses. 3 quarter hours.

211. **Introduction to English Literature.** Prerequisite or concurrent: Humanities 101-102. Class study of selected masterpieces of English literature from Chaucer to 1900, supplemented by lectures, collateral reading, and reports. English 211 and 212 may be taken in any order. 5 quarter hours.

212. **Introduction to English Literature.** A continuation of English 211 to complete the year's work in Sophomore English Literature. 5 quarter hours.

Note: All courses numbered 300 and above are open only to juniors and seniors unless otherwise indicated in the description of a course.

310. **The Romantic Poets of the Early Nineteenth Century.** Prerequisites: English 101-102-103. An intensive study of the poetry of Wordsworth, Coleridge, Byron, Shelley, and Keats. 5 quarter hours.

311. **American Literature.** Prerequisites: English 101-102-103. An introduction to the chief American writers from Frenau and Franklin to Robert Frost, with consideration of such dominant factors in the shaping of American literature as the Puritan tradition, the frontier spirit. The courses may be taken in any order. 5 quarter hours.

312. **American Literature.** A continuation of English 311 although it need not be preceded by English 311. 5 quarter hours.

417. **Browning.** Prerequisites: English 101-102-103. The poetry of Browning is read, and a study is made of his philosophy. 5 quarter hours.

GEOGRAPHY

201-202. World Geography. Regional study of relations of human activities to natural environmental condition of countries and continents. Conservation of natural resources. Credit for full sequence only. This course may not be taken by students who have had Geography 101-102-103. 4 quarter hours each course.

210. Conservation of Natural Resources. Emphasis is placed on need for conservation of natural life, energy resources, land and water resources; and the need, particularly in the United States, for readjusting our work patterns and land utilization of our natural environment. 5 quarter hours.

HEALTH EDUCATION

319. Health Education in the Elementary School. This course is designed to give to elementary teachers an understanding of the growth and development of the elementary school child; an appreciation of the necessity for providing a healthful mental, social, emotional, and physical school environment; an appreciation of the role of the teacher in school health services; and an introduction to the subject matter and materials of health instruction at the elementary level. Sources of health information will be explored. Prerequisites: Prior to enrollment in this course, H En. 319, students must have completed Introduction and Principles of Education, General Psychology, Educational Psychology. This is a junior level course and should not be taken until the proper foundation has been acquired. 3 quarter hours.

HOME ECONOMICS, FOOD AND NUTRITION

Nutrition

105. Elements of Nutrition. A survey of the elements of nutrition and of the factors influencing the ability of the individual and the family to secure and maintain good nutritional status. No credit if taken in addition to Home Economics 101-102. 3 quarter hours.

Clothing and Textiles

107. Textiles. An introductory study of textiles; the fibers, structure, design, finish, and quality of fabrics for household and personal use. 3 quarter hours.

Home and Family Life

360. Economic Problems of the Household. Prerequisite: Sophomore standing. The use of the family's resources in satisfying needs and gaining the satisfaction desired by the family and the individual. The relation of standards of living to goals for family life. 4 quarter hours.

361. Housing in Relation to Family Life. Prerequisite: Junior standing. A study of housing as it relates to and conditions family living. 3 quarter hours.

465X. The Child in the Home. Prerequisite: Psychology and Senior standing. Factors in the home situation as they affect guidance and care of the pre-adolescent child. Open to students in all divisions of the College. 4 quarter hours.

HISTORY

101-102. Development of Modern Society. A survey of the social, economic, political, and intellectual forces which serve to explain the rise and growth of the institutions of the modern world. Credit for the complete sequence only. 3 quarter hours each course.

181-182-183. History of the Americas. Prerequisite: History 101-102. A history of the discovery, exploration, and settlement of the Americas. The development of Canada, the United States, and Latin America. 3 quarter hours each course. Credit for all quarters.

225. Introduction to Florida History. A survey of Florida history. Does not duplicate 421-422-423, History of Florida. Offered only through the General Extension Division. 4 quarter hours.

275. Greek Civilization. Prerequisite: History 101-102. A survey of the civilization of the Ancient Near East and a more intimate study of the economic, social, political, and cultural life of the Greeks. 5 quarter hours.

276. Roman Civilization. Prerequisite: History 101-102. A study of Rome, political, social, economic, and cultural, from its beginning to the end of the Germanic invasions. 4 quarter hours.

MODERN LANGUAGES

French

301. Modern French Readings. Prerequisite: French 201-202-203 or equivalent. Study of nineteenth and twentieth century authors for the purpose of affording a well-integrated knowledge of modern literature. Representative works of Balzac, Flaubert, Zola, Maupassant, Daudet, France, and Loti. 4 quarter hours.

Spanish

301-302. Modern Spanish Readings. Prerequisite: Spanish 201-202-203, or equivalent. Reading of the leading nineteenth and twentieth century authors for the purpose of affording a well-integrated knowledge of modern literature. These courses may be taken in any order. 301, Novel; 302, Drama. 4 quarter hours each course.

MUSIC

101, 102, 103. Elementary Harmony. This is an introductory course for those beginning the study of harmony theory. The writing of all major and minor scales, intervals, formation of chords and their inversions, as well as the use of this material in harmonizing melodies will be included. Some use will be made of the seventh chord. 2 quarter hours each course.

140. History of Music. The course will give a survey of music history from the earliest times of the savage, early occidental and oriental to the period of the Romantic composers at the beginning of the nineteenth century. 3 quarter hours.

201, 202, 203. Harmony. This course will include the study of all seventh chords, and their use in harmonizing melodies. Original work using this material will be required. Modulations and the study of all augmented chords with original work completes the course. This course should be preceded by Harmony 101, 102, 103. 2 quarter hours each part.

301, 302, 303. Counterpoint. Counterpoint is the art of adding melodies to a given melody. Abundant practice in the writing of counterpoint leading to the composition of Inventions in 2, 3, and 4 parts comprise the main feature of the course. Counterpoint should be preceded by Harmony 201, 202, 203. 2 quarter hours each course.

SOCIAL WORK

205. Preparation for Marriage. This is a course on the freshman and sophomore level for the purpose of preparing students for successful marriage and parenthood. The basic problems of courtship, mate selection, the engagement, marriage, rearing children, and related problems come within the scope of the course. Although the course is designed to prepare students for successful marriage and parenthood, it will also be helpful to persons who will be engaged in marriage and family counseling and will deal with the psychological and social adjustments of married people. 3 quarter hours.

368. The Field of Social Work. An introductory course presenting a general view of the entire field of social work. Attention is given to the principal institutions and agencies as well as the forms, processes and techniques of social work. This course is arranged for teachers, religious workers, etc., as well as for social workers. 4 quarter hours.

SOCIOLOGY

407. Educational Sociology. Prerequisite: Sociology 201-202-203 or junior or senior standing. A consideration of the community in terms of the past and present, an analysis of its comparative position, and the place of the school in promoting improvement. 4 quarter hours.

GENERAL EXTENSION DIVISION

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GENERAL EXTENSION DIVISION RECORD

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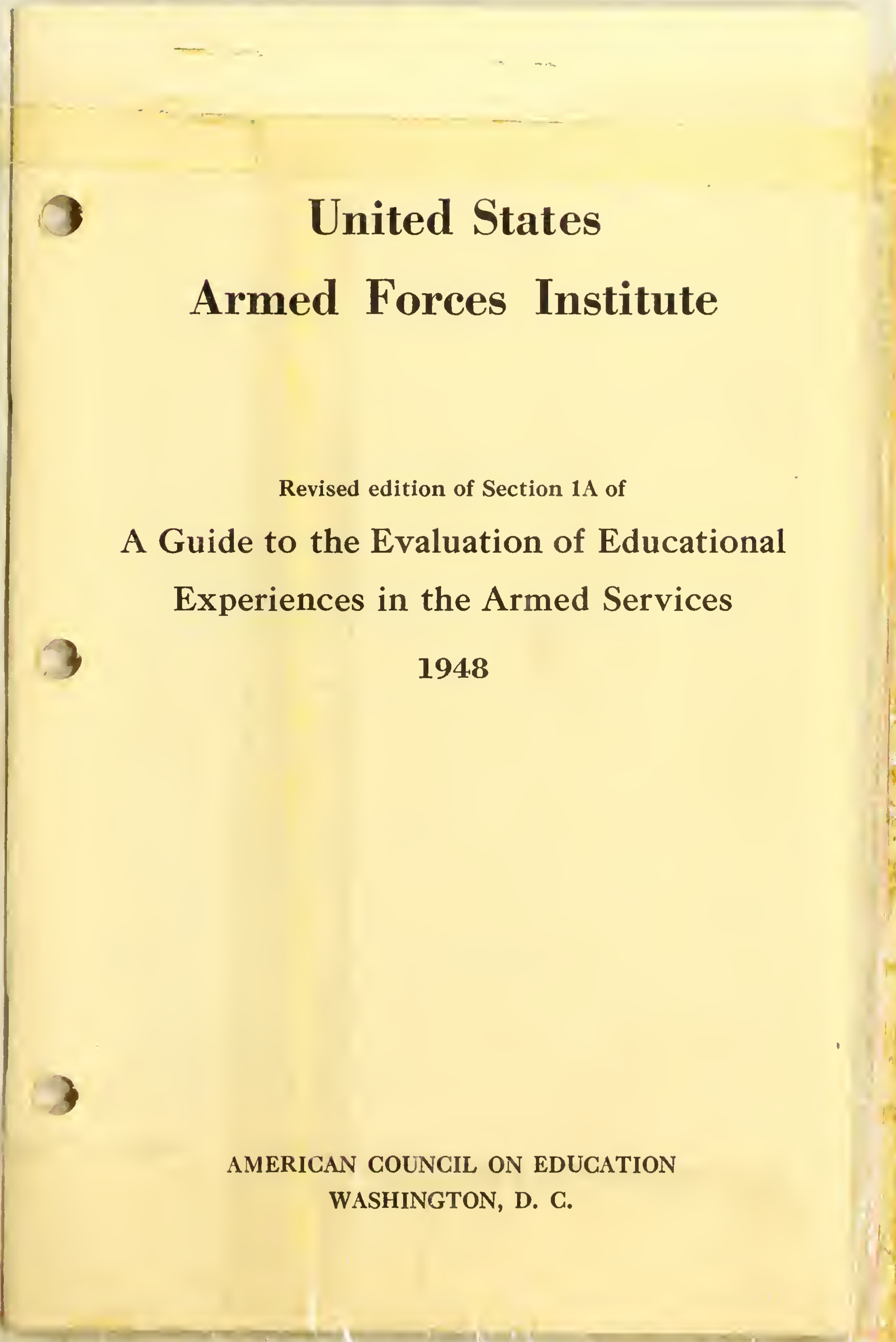
BROCHURE VIII



United States
Armed Forces Institute

Revised edition of Section 1A of

A Guide to the Evaluation of Educational
Experiences in the Armed Services

1948

AMERICAN COUNCIL ON EDUCATION
WASHINGTON, D. C.

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Introduction

A Guide to the Evaluation of Educational Experiences in the Armed Services was prepared by a special committee of the American Council on Education. A staff directed by Mr. George P. Tuttle, registrar of the University of Illinois, compiled the materials and arranged for their original distribution. Since it was desirable to make information available to civilian educational institutions as rapidly as possible, for two and one-half years beginning in 1944 the *Guide* was published as a series of parts.

At the beginning it was necessary to explain in considerable detail the nature of the courses and the tests in the United States Armed Forces Institute (USAFI) program. Procedures were suggested for acquainting civilian educators with the USAFI materials, for utilizing them, and for establishing local norms and institutional standards.

During the war the correspondence and self-teaching courses were revised as materials became outmoded. Since the war other revisions, additions, and deletions in curricular offerings, and changes in procedures have been necessary to meet the requirements of the peacetime services.

Thus it seems desirable to rewrite the entire USAFI section, organizing the materials into a convenient form and simplifying the explanations, since the program is now generally well understood by educators. This pamphlet is designed to replace SECTION 1A (*Subject:* The United States Armed Forces Institute) which in the original publication was made up of a series of parts and in the bound edition constitutes pages 9 through 68. **The credit recommendations made in this revision supersede all previous recommendations.** In this new pamphlet the arrangement of materials, both in their order and form, has been modified. Descriptions of the USAFI materials have been condensed and brought up to date.

Location:

Madison 3, Wisconsin.

The United States Armed Forces Institute is an official military (Army, Navy, and Air Force) agency operating under Department of the Army directives. It offers four types of service:

1. **Instructional Service.**—This service includes: (1) correspondence courses that have been developed for USAFI, (2) established university correspondence courses offered to armed services personnel through a cooperative arrangement between higher institutions and USAFI, and (3) both self-teaching and standard reprint texts for use by individuals or group-study classes.

2. **Examination Service.**—Examination staffs, composed of civilian educators, prepare for the United States Armed Forces Institute three types of examinations (copyrighted by the American Council on Education), namely: (1) End-of-Course Tests, (2) Subject Examinations, and (3) Tests of General Educational Development. More information concerning these examinations appears later in this pamphlet.

3. **Accreditation Service.**—USAFI does not grant or recommend credit. It only relays to educational institutions or to civilian employers the **credit recommendations** of the American Council on Education. It provides USAFI test and course completion data upon which educational institutions may base their credit evaluations. Upon request it forwards official reports of work completed by service personnel to schools and employers.

4. **Advisement Service.**—This is a counseling service available to all armed services personnel. It has been developed to handle inquiries from men and women in the armed services regarding USAFI curricular offerings. It cooperates with schools, colleges, and employers by answering letters of general inquiry, by distributing information concerning the requirements of various professions and jobs, and by giving advice on educational objectives.

Subject: U. S. Armed Forces Institute Correspondence Courses

This section on United States Armed Forces Institute correspondence courses is meant to serve as a guide for the granting of credit. The recommendations made by consultants and staff of the American Council on Education are based upon studies of the courses and their terminal examinations. The courses are designated by their USAFI numbers. USAFI correspondence courses are of two types: (1) academic, both secondary and college levels, and (2) technical-vocational.

The first correspondence courses made available to service personnel were existing commercial correspondence courses purchased by USAFI. As more appropriate courses became available through the efforts of the USAFI Editorial Staff, which functioned under the direction of the American Council on Education, the original correspondence courses were withdrawn. However, it should be recognized that service personnel who completed these original courses may still ask that reports of their achievement be sent to educational institutions. A complete list of these original correspondence courses, numbered without a letter prefix from 131 to 951, with their corresponding credit recommendations, appears in this pamphlet on pages 27–28. **It is recommended that credit be granted for these completions only when the official certification is received by the educational institution directly from USAFI. This same recommendation applies to all USAFI correspondence courses, self-teaching courses, off-duty classes, and reports of any USAFI tests or examinations.**

The Editorial Staff selected the best available correspondence courses and the most appropriate and acceptable testing materials for the USAFI programs. As these were made available, they were divided into three groups: (1) general secondary school correspondence courses, numbered from 50 through 199 with prefix "H"; (2) technical-vocational correspondence courses (secondary school, terminal junior college, and college levels), numbered from 200 through 499 with prefix "J"; and (3) general college courses, numbered from 500 through 799, with a prefix "C." After the war, as the USAFI program was geared to meet peacetime requirements, some courses were dropped, new courses were added, and some courses were revised. These revised substitute courses have retained the number of the original course, but the letter prefix is changed to "X." Thus Course X 117 is a revision of H 117, X 412 is a revision of J 412, and X 502 is a revision of C 502. In the "X" courses, it is the *number* rather than the letter which designates the level or type: 50–199, general secondary school; 200–499, technical-vocational; and 500–799, college.

All correspondence courses (prefixed by H, J, C, or X) which have been offered by USAFI up to the present time appear in tables on pages 19–23 of this pamphlet. All of these courses have End-of-Course Tests—except as noted in the tabular lists—which tests were prepared by competent civilian educators, specialists in the subject-matter fields and in testing techniques. The passing scores were determined by civilian educators, as were the standards for the "With Distinction" rating. The grading scale for these courses is: "With Distinction," "Satisfactory," and "Unsatisfactory." Where no USAFI examination is available, credit by local examination is recommended.

Official reports of course completions forwarded by Headquarters USAFI to civilian educational institutions include: (1) a description of the course, (2) either a test report form indicating the score received on the End-of-Course Test or a statement indicating the average lesson grade if a test was not available, and (3) the credit recommendation made by the American Council on Education. It is important to note that credit for correspondence courses is recommended **only** upon the successful completion of the USAFI End-of-Course Test, an appropriate USAFI Subject Examination, or by an appropriate examination administered by the accrediting institution.

Where no End-of-Course Test is available, USAFI records a "Satisfactory Completion," if the average grade on all the lessons is 70 percent or higher. However, **no credit** is recommended unless the completion is validated by examination, as indicated above.

Correspondence Courses through Cooperating Universities

More than fifty colleges and universities offer their regular correspondence and extension courses to members of the armed forces through a cooperative arrangement with USAFI, which pays a part of the cost.

All texts, instructional materials, lesson services, and tests are provided by the college or university offering the courses.

It is recommended that credit be granted as normally assigned by the institution offering the course. Certificates of completion should be by regular transcript of the institution offering the course or by official report directly from USAFI.

"Education Manual" is the term applied to USAFI textbooks on the basis of which self-study may be pursued or classwork may be organized in any of the armed services. Some of the Education Manuals are standard college or high school texts reprinted in special editions for USAFI, others are rewrites of standard texts; and still others are courses written especially for use by service personnel. In many instances, check-up tests with answers and teaching aids for individual or group study have been added. USAFI End-of-Course Tests, prepared by civilian educational specialists and administered under secure conditions, measure the educational achievement of students using the Education Manuals.

In this pamphlet, the Education Manuals—commonly called EM's—are presented in two numerical lists as they were in the original *Guide* materials. The first list includes courses normally at the secondary school and terminal junior college levels. The second contains courses at the college level. In about a dozen instances, where they are equally appropriate and have been evaluated on both levels, the EM's appear on both secondary and college lists. It should be noted that the number does not identify the level of the course. For example, the secondary school and terminal junior college subjects include numbers from 100 to 998, and the college subjects from 104 to 961. Thus, it will be necessary for educators to refer to both lists in order to determine the level of the EM course. Credit for EM's should be based exclusively upon the satisfactory completion of the corresponding USAFI End-of-Course Test or upon an appropriate USAFI Subject Examination. **Schools and employers should accept official test reports only when issued directly to them by USAFI Headquarters.**

Accreditation by Examination

Introduction

The purposes of this section of the *Guide* are:

1. To outline briefly the nature and purposes of the examinations prepared by the Examinations Staffs for the United States Armed Forces Institute for use in the accreditation of military training and experience.

2. To explain how these tests are administered to men and women in the military services, and how the test results are made available to educational institutions.

3. To explain how certain of these tests, or their comparable forms, may be obtained by civilian educational institutions for administration to veterans not previously tested, for the establishment of local norms, or for general school use.

4. To recommend procedures in the use of USAFI tests by civilian educational institutions.

5. To recommend critical (or minimum) scores and corresponding amounts of credit to be granted on the basis of test performance.

No attempt is made here to present a thoroughgoing discussion of accreditation by examination, or to review the advantages of examination procedures over other bases for accreditation. Such discussions are already available in publications which have been widely distributed to educators. It is assumed that the reader of this section of the *Guide* is familiar with these publications and that he has given careful study to the article on "The Use of Tests in the Accreditation of Military Experience and in the Educational Placement of War Veterans," which appeared in *The Educational Record* for October 1944.

THE END-OF-COURSE TESTS

The USAFI End-of-Course Tests were prepared by the Examinations Staffs to measure the achievement of those taking correspondence courses, self-teaching courses, and group-instruction courses, using USAFI correspondence course materials or Education Manuals. These tests were prepared in only one form whose security has been maintained throughout the program. They are not available to educators for examination purposes or for determining local norms. As indicated earlier, the passing score for each End-of-Course Test was determined by competent civilian educators.

THE SUBJECT EXAMINATIONS

The Subject Examinations of the United States Armed Forces Institute are tests of achievement in regular secondary school and college subjects. Each of the tests is completely objective in scoring, is long enough to yield highly dependable measures of individual achievement, and has been standardized for a representative sample of civilian students who had just completed a regular classroom course of the same content. The subjects or fields for which these tests are available are listed on pages 40–43, together with the suggested minimum scores for granting credit for each of the Subject Examinations. Wherever minimum scores are considered tentative, that is, where they are based upon tentative norms, the score is followed by the letter "T." **The credit recommendations and minimum scores given in this pamphlet supersede those given in all earlier publications and supplements.** In the original *Guide* materials, detailed descriptions of the subject matter covered by the Subject Examinations were provided. In the complete bound edition these descriptions appear on pages 50–62. In this pamphlet these detailed descriptions have been omitted and the tabular presentation includes the amount of recommended credit and the minimum scores suggested for granting such credit for each of the two forms of the Subject Examinations. If an institution wishes to refer to the exact areas covered in these tests, the page describing them in the original *Guide* materials should be preserved.

It is recommended that credit for the subject examinations be granted only when official certification is received directly from Headquarters of USAFI.

If the Subject Examinations are administered by agents of the Veterans Testing Service or other civilian educational agencies, the reports should be received directly from them.

Each of these Subject Examinations may be used to determine whether the achievement of a serviceman or veteran is the equivalent of that expected of regular civilian students for satisfactory completion of a corresponding course of classroom instruction. Suppose, for example, that a serviceman feels that his military training and experiences, both formal and informal, have been such as to make a special contribution to his knowledge and understanding of physics, and that as a result of this experience, together with what he had learned about physics before entering the service, he believes that he "knows as much physics" as many civilian students who have just passed an introductory college course in the subject. At his request, he may take the

USAFI Subject Examination in college physics, and may have his score reported to the college of his choice. If the college concerned considers his performance satisfactory, he may be granted credit for a course in college physics without actually having taken a formal course.

Most of the Subject Examinations were prepared in two parallel or comparable forms. Form A is used by the U. S. Armed Forces Institute for testing members of the armed services while they are on active duty, and by agencies of the Veterans Testing Service (a division of Educational Testing Service but operating under policies determined by the American Council on Education) which make the tests available to veterans. Form B is used by civilian educational institutions, primarily in (1) acquainting civilian educators with the general nature and content of the tests, (2) establishing local norms through the testing of civilian students, and (3) for testing veterans and civilians for accreditation purposes. The B forms of the Subject Examinations[1] may be purchased by educational institutions from Educational Testing Service, 15 Amsterdam Avenue, New York 23, New York. Since many institutions use these forms for accreditation purposes, and for other obvious reasons, educational institutions obtaining these tests are strongly urged to keep the contents as confidential as possible and to maintain their security.

Further information concerning the nature and purposes of these tests may be found in the *Manual for Subject Tests* provided with them. The *Manual* presents brief descriptions of the organization and content of each of the tests, gives general directions for administering and scoring the tests and for interpreting the scores obtained, and discusses the norms and their use in the evaluation of achievement.

THE TESTS OF GENERAL EDUCATIONAL DEVELOPMENT

The Tests of General Educational Development are designed to measure the extent to which all of the educational experiences of the serviceman or veteran, particularly his informal or self-educational experiences, have contributed to his ability to "carry on" in a program of *general* education or to his educational development which might have resulted had he attended a regular academic high school, or the first year of a liberal arts college. The Subject Examinations referred to in preceding paragraphs are not appropriate for the measurement of the general educational development of the serviceman or veteran, particularly with respect to his *informal* in-service experiences. A full discussion of the need for special general tests for this purpose may be found in the articles on "The Use of Tests in the Accreditation of Military Experience and the Educational Placement of War Veterans" in *The Educational Record* for October 1944, and in the *Examiner's Manual for the Tests of General Educational Development* which is sent with the tests.

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[1] Formerly distributed by the Cooperative Test Service, now a division of Educational Testing Service.

Separate batteries of the Tests of General Educational Development have been prepared for use at the high school and college levels. The high school level battery consists of five comprehensive examinations, one for each of the fields of English, the social studies, the natural sciences, literature, and mathematics. These tests are intended for use primarily with servicemen or veterans who either had never attended high school or had completed only a part of their high school course before entering the service. With such individuals these tests may be used to determine whether—through formal and informal educational experiences both in and out of the service—they have acquired the *equivalent* of a general high school education, or are as able to carry on in a program of general education at the college level as are students who have formally completed high school.

The college level battery consists of four comprehensive examinations in English, the social studies, the natural sciences, and literature. These tests are intended primarily for use with servicemen or veterans who had completed or almost completed their high school course before entering the service but who had not begun their college education. With such individuals these tests may be used to determine whether all of their formal and informal educational experiences have given them the equivalent of the broad cultural basis for later specialization which they might otherwise have secured through comprehensive introductory or survey courses in the social studies, the natural sciences, literature, and English at the freshman or sophomore college level.

Secondary School Level

Description.—All forms of the high school level GED tests consist of five parts: Test 1, *Correctness and Effectiveness of Expression*; Test 2, *Interpretation of Reading Materials in the Social Studies*; Test 3, *Interpretation of Reading Materials in the Natural Sciences*; Test 4, *Interpretation of Literary Materials*; Test 5, *General Mathematical Ability*.

The tests in the social studies, natural sciences, and the literary materials require the examinee to *interpret* and *evaluate* a number of reading selections representative of those he will study in subsequent work in school. The discussions are written for readers who are presumably already well informed in the general area involved. The tests require that an integrated body of knowledge be brought to bear on particular problems.

The test of *Correctness and Effectiveness of Expression* consists of a spelling section and of well-written prose passages which have been altered to include common and serious errors found in students' writing. The examinee is required to choose the most proper one of several ways in which to correct the errors.

The test of *General Mathematical Ability* indexes general problem-solving ability of a practical sort. The types of problem situations represent a wide range of concepts, e.g., simple business transactions, insurance, taxation, algebra, geometry, measurement, scale drawings, graphs, and indirect measurement.

The norms which are reported for the high school level GED tests are based upon the test results of more than 35,000 graduating seniors in secondary schools throughout the country. Norms are given for the United States and in terms of regional distributions: New England States, Middle Atlantic States, Southern States, North Central States, Northwestern States, and California. A detailed description of the standardization process is included in the Examiner's Manual for each level.

There are several forms of the high school level GED tests, all of which have been equated and are, therefore, equivalent. Standard scores on all forms represent the same achievement.

Forms A, Y, and Z are used exclusively within the armed services for men on active duty. They are all carefully protected and are administered under rigid standards of security. Achievement on the basis of these forms should be acceptable only when reported to the accrediting institutions directly by Headquarters of the U.S. Armed Forces Institute at Madison, Wisconsin. These official test report forms include the standard score and the percentile norm for the United States as a whole for each of the five tests.

Form B may be purchased by educators from Educational Testing Service. This form is not intended for use in accreditation, but rather in (1) acquainting civilian educators with the general nature and content and the important characteristics of the other parallel or equivalent forms, and (2) establishing local norms through the testing of civilian students. There is only one exception—that scores on Form B be accepted for accreditation from Veterans Administration hospitals in hardship cases which have been approved in advance by the civilian school or college.

Forms C and D (and when available, E and F) are highly secure forms, administered only by official agencies of the Veterans Testing Service established by the American Council on Education, which agencies have the approval and operate under the supervision of the various state departments of education. The results of these forms may be obtained only from these official agencies and should be reported directly to the accrediting institution on an official form used for that purpose. These reports include for each test the standard score and the percentile rank for the United States as a whole.

Recommendations.—It is recommended that a secondary school or state department of education should grant a diploma or equivalency certificate if the examinee satisfies *either* (not necessarily both) of the following requirements, provided that legal requirements of local authority have been met:

1. The examinee has made a standard score of 35, or above, on *each* of the five tests in the battery, *or*

2. The examinee has made an *average* standard score of 45, or above, on the five tests in the battery.

In general, 75 to 85 percent of the students who were graduated in 1943 from public high schools throughout the country would meet one of the alternative requirements.

Since it is felt that systematic education normally is best attained by regular attendance in school, it recommended that the Tests of General Educational Development not be administered or recognized for high school equivalency purposes until after the class of which the testee was a member has been graduated.

College Level

Description.—In the college level Tests of General Educational Development there are four examinations. The general descriptions are the same as for the secondary school tests (see above) except that there is no examination in mathematics in the college battery. It is suggested that the special areas in college mathematics should be tested by means of a subject-matter test, such as: algebra, geometry, trigonometry.

Norms have been established for three categories of institutions (*Examiner's Manual*, page 7) based upon mean scores of entering freshmen on the 1941 *American Council on Education Psychological Examination*. The categories are as follows: Type I, those institutions whose freshmen made a mean raw score above 113; Type II, those institutions whose freshmen made a mean raw score between 95 and 113; Type III, those institutions whose freshmen made a mean raw score below 95. Each school may decide for itself which of these three types of norms is most appropriate for its own students. The percentile norms (see the *Manual*) are based on the scores of civilian students who were just completing, with a passing grade, a course in the area covered by the examination.

Use.—The Tests of General Educational Development (college level) are intended to be used to appraise the student's educational accomplishments in broad subject areas, whereas the Subject Examinations are to appraise his achievement in typical college courses. Each of the college level GED tests may be used independently of one another. Each should be used as a basis for granting credit in the broad subject area covered by the examination.

Recommendations.—The critical (or minimum) scores recommended as the basis for baccalaureate credit in each area and for each of the types of institutions are as follows:

Test I: Correctness and Effectiveness of Expression: Six semester hours. For Type I institutions, 55; for Type II institutions, 50; for Type III institutions, 47.

Test II: Interpretation of Reading Materials in the Social Studies: Six semester hours. Type I, 60; Types II and III, 53.

Test III: Interpretation of Reading Materials in the Natural Sciences: Six semester hours. Type I, 61; Types II and III, 56.

Test IV: Interpretation of Literary Materials: Six semester hours. Type I, 57; Type II, 53; Type III, 49.

In general, about 80 percent of the civilian students who are actually completing and passing survey courses in the corresponding subject areas would meet the foregoing requirements.

1. GENERAL SECONDARY SCHOOL CORRESPONDENCE COURSES

Number	Course Name	Credit Recommendation[1] Carnegie Units
H 50	Bookkeeping and Accounting I	No credit unless presented with H 51
H 51	Bookkeeping and Accounting II	½ unit if presented with H 50
H 52	Bookkeeping and Accounting III	½
H 53	Bookkeeping and Accounting IV	½
H 54	Bookkeeping and Accounting V	½
H 55	Bookkeeping and Accounting I	No credit unless presented with H 56
H 56	Bookkeeping and Accounting II	½ unit if presented with H 55
H 57	Bookkeeping and Accounting III	½
H 58	Bookkeeping and Accounting IV	½
H 59	Business Arithmetic	½
H 60	Bookkeeping and Accounting V	½
H 61	Economics	½
X 61	Economics	½
H 62	Economic Geography	½
H 63	Business Law	1
X 63	Business Law	1
H 64	Salesmanship	½
H 65	The Small Business	½
H 66	Fundamentals of Typewriting	½
H 67	Business Typewriting	½
H 68	Army Typewriting	½
H 69	Fundamentals of Typewriting	½
H 71	Elementary Gregg Shorthand	1
H 72	Advanced Gregg Shorthand	1
H 73	Shorthand (Gregg)	1
H 74	Advanced Shorthand (Gregg)	1
H 75	Business Correspondence	½
H 83	English Grammar	½
H 84	The Mechanics of English	½
H 85	Building Good Sentences	½
H 87	Ninth-Grade English I	½
X 87	Ninth-Grade English I	½
H 88	Ninth-Grade English II	½
X 88	Ninth-Grade English II	½
H 89	Tenth-Grade English I	½
X 89	Tenth-Grade English I	½
H 90	Tenth-Grade English II	½
X 90	Tenth-Grade English II	½
H 91	Writings of English Authors I	½
H 92	Writings of English Authors II	½
H 93	Writings of American Authors I	½
H 94	Writings of American Authors II	½
H 95	Practical English Usage I	½
X 95	Practical English Usage I	½
H 96	Practical English Usage II	½
X 96	Practical English Usage II	½
H 97	Review Grammar	½

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[1] Credit should not be granted unless the successful completion of the course is validated by a measure of competence: a score on either the End-of-Course Test or the appropriate Subject Examination. Test results should be accepted only when reported directly to the educational institution by Headquarters, United States Armed Forces Institute, Madison 3, Wisconsin.

Number	Course Name	Credit Recommendation[1] Carnegie Units
H 98	Advanced High School Composition	½
H 110	American History I	½*
H 112	American History II	½*
H 113	Civics	½
H 114	World History I	½
H 115	World History II	½
H 116	Ancient History	1
H 117	American History	1
X 117	American History	1
H 117a	American History (1492–1865)	½
H 117b	American History (1865–1942)	½
X 117a	American History (1492–1865)	½
X 117b	American History (1865–1942)	½
H 133	Review Arithmetic I	No credit unless presented with H 134
H 134	Review Arithmetic II	½ unit if presented with H 133
H 136	A First Course in Algebra I	½
H 137	A First Course in Algebra II	½
H 138	Beginning Algebra	½
H 139	Intermediate Algebra	½
H 140	Advanced Algebra	½
H 141	Plane Geometry I	½
H 142	Plane Geometry II	½
H 143	Plane Geometry I	½
X 143	Plane Geometry I	½
H 144	Plane Geometry II	½
X 144	Plane Geometry II	½
H 145	Solid Geometry	½
H 146	Plane Trigonometry	½
H 147	Trigonometry	½
H 148	Review Arithmetic	½
H 149	Beginning Algebra (Duplicates Course H 138 and H 139)	1
H 151	General Science (non-laboratory)	½
H 152	Inorganic Chemistry (non-laboratory)	½
H 153	Physics I: Mechanics	No credit unless presented with H 154
H 154	Physics II: Heat, Sound, and Light	½ unit if presented with H 153
H 155	Physics III: Electricity	½
H 156	Physics (non-laboratory) (This course covers H 153, H 154, and H 155)	1
H 157	Physiography	½
H 158	Biology I	½
H 159	Biology II	½
H 175	Basic Mathematics I (Arithmetic and Geometry)	½
H 176	Basic Mathematics II (Elementary Algebra and Trigonometry)	½

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[1] Credit should not be granted unless the successful completion of the course is validated by a measure of competence: a score on either the End-of-Course Test or the appropriate Subject Examination. Test results should be accepted only when reported directly to the educational institution by Headquarters, United States Armed Forces Institute, Madison 3, Wisconsin.

*No USAFI End-of-Course Test available. Credit in the amount recommended should be granted only upon the basis of appropriate local examination by the accrediting institution.

2. TECHNICAL-VOCATIONAL CORRESPONDENCE COURSES

NOTE: Certain courses in this list are recommended for baccalaureate degree credit. Where this is so, prerequisites and textbooks are indicated.

		CREDIT RECOMMENDATION[1]		
		Units	*Semester Hours*	
NUMBER	COURSE NAME	*Secondary*	*Jr. Col. Terminal*	*Baccalaureate*
J 200	Aerodynamics	½	3	
J 201	Aeronautical Meteorology	½	3	
J 202	Aeronautical Navigation	½	3	
J 203	Aviation Engines	½	3	
J 204	Airplane Maintenance I	No credit unless presented with J 205		
J 205	Airplane Maintenance II For completion of this course and J 204	½*	3*	
H 211–15	Auto Mechanics Five courses as follows: The Engine; Cooling, Lubrication, and Fuel Systems; Automotive Electricity; The Power Flow; Chassis Units. NOTE: Any of these courses may be presented separately.	No secondary school credit is recommended for a single course. For any 2 courses, ½ unit; 3 courses, 1 unit; 4 courses, 1½ units; for all 5 courses, 2 units. For junior college terminal credit, 2 semester hours is recommended for each course.		
J 216	Automotive Power Plants	½*	3*	
J 217	Automobile Chassis and Running Gear	½*	3*	
J 218	Automobile Electrical Equipment	½*	3*	
J 226–29	Military Correspondence; Military Orders; Basic Military Records I; Basic Military Records II. For the completion of all 4 courses, a total of	½	3	
J 231	Air Conditioning	½	3	
X 231	Air Conditioning, Heating, and Ventilating.	1	5	
J 232	Basic Construction Work	½	3	
J 233	Details of Concrete Structures	½*	3*	
J 234	Methods of Concrete Construction and Estimating	½	3	
J 235	Heating and Ventilation	1	6	
J 236	Masonry Construction	½	3	
J 237	Metal Construction	½	3	
J 238	Operations Preliminary to Building	½*	3*	
X 239	Plumbing	½	2	
J 239	Plumbing and Gas Fitting I	No credit unless presented with J 240		
J 240	Plumbing and Gas Fitting II For completion of this course and J 239	½*	3*	
J 241	Specifications, Estimating, and Contracts	½	3	

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[1] Credit should not be granted unless the successful completion of the course is validated by a measure of competence: a score on either the End-of-Course Test or the appropriate Subject Examination. Test results should be accepted only when reported directly to the educational institution by Headquarters, United States Armed Forces Institute, Madison 3, Wisconsin.

*No USAFI End-of-Course Test available. Credit in the amount recommended should be granted only upon the basis of appropriate local examination by the accrediting institution.

Number	Course Name	Credit Recommendation[1]		
		Units	*Semester Hours*	
		Secondary	*Jr. Col. Terminal*	*Baccalaureate*
J 242	Structural Engineering I................ Prerequisite: A working knowledge of mathematics through calculus, mechanics, statics, strength of materials. Textbook: *Reinforced Concrete Construction*, Vol. II, *Retaining Walls and Buildings*, G. A. Hool, 2nd ed., 1927			3
J 243	Structural Engineering II................ Prerequisite: A working knowledge of mathematics through calculus, a preliminary course in reinforced concrete design, statics, strength of materials. Textbook: *Reinforced Concrete Construction*, Vol. III, *Bridges and Culverts*, G. A. Hool, 2nd ed., 1928			3
J 244	Structural Engineering III............... Prerequisite: College algebra, trigonometry, mechanics. Textbook: *The Theory and Practice of Modern Framed Structures*, Part I, Johnson, Bryan, and Turneaure, 10th ed., 1927			3
J 246	Wood Construction.....................	½	3	
X 246	Wood Construction.....................	1	6	
J 251	Reinforced Concrete Design.............	**	**	
J 261	Freehand Drawing......................	½*	3*	
J 263	Mechanical Drawing....................	1	6	
J 264	Electrical Drawing.....................	½*	3*	
J 265	Mapping...............................	½*	3*	
J 266	Surfaces...............................	½*	3*	
J 267	Airplane Drawing......................	½*	3*	
J 268	Elementary Architectural Drawing.......	½*	3*	
J 269	Freehand and Ornamental Drawing.......	½*	3*	
J 275	Ship Drawing..........................	½*	3*	
J 276	Practical Projection....................	½*	3*	
J 277	Sheet Metal Drafting...................	½*	3*	
J 279	Art Techniques I.......................	½*	3*	
J 280	Art Techniques II......................	½*	3*	
J 281	Art Techniques III.....................	½*	3*	
J 282	Perspective and Composition............	½*	3*	
J 283	Drawing for Reproduction...............	½*	3*	
J 284	Commercial Art........................	½*	3*	
X 284	Commercial Art........................	½	3	
J 286	Pen and Brush Lettering................	½*	3*	
J 287	Designing Show Cards..................	½*	3*	

[1] Credit should not be granted unless the successful completion of the course is validated by a measure of competence: a score on either the End-of-Course Test or the appropriate Subject Examination. Test results should be accepted only when reported directly to the educational institution by Headquarters, United States Armed Forces Institute, Madison 3, Wisconsin.

*No USAFI End-of-Course Test available. Credit in the amount recommended should be granted only upon the basis of appropriate local examination by the accrediting institution.

**No USAFI test available. Amount of credit should be determined by appropriate local examination by the accrediting institution.

		CREDIT RECOMMENDATION[1]		
		Units	*Semester Hours*	
NUMBER	COURSE NAME	*Secondary*	*Jr. Col. Terminal*	*Baccalaureate*
J 310	Radio for Beginners	½	2	
J 312	Electrical Measuring Instruments	½	3	
J 313	Elementary Electricity	½	3	
J 314	Applied Electricity	½*	3*	
X 314	Industrial Electricity	1	6	
J 315	Principles and Applications of Electric Illumination	½	3	
J 316	Radio for Beginners	½	3	
J 317	Basic Radio Code	**	**	
J 318	Radio Communication I	½	3	
J 319	Radio Communication II	½	3	
J 320	Theory and Construction of Electrical Machines	½*	3*	
J 321	Electrical Engineering I Prerequisite: College algebra, trigonometry, magnetism and electricity, as given in college physics. Textbook: *Direct-Current Machinery*, McFarland, Thomas C., 1938			3
J 322	Electrical Engineering II Prerequisite: J 321. Textbook: *Direct-Current Machinery*, McFarland, Thomas C., 1938			3
J 323	Electrical Engineering: Alternating Current Machinery Prerequisite: Mathematics through calculus. Textbook: *Electrical Circuits and Machinery*, Vol. II, Hehre and Harness, 1942; *Fourplace Mathematical Tables*, Fiske and Longley, 1925			3
J 331	Introduction to Agriculture	1		
J 332	Soils	½		
J 333	Farm Crops	½		
J 334	Farm Forestry	½	2	
J 335	Farm Management	1		
J 336	Livestock Farming	1		
J 338	Dairy Farming	½		
J 339	Poultry Farming	½		
J 342	Vegetable Crops Textbook: *The Vegetable Growing Business*, Watts and Watts, 1940	½		2
J 346	Marine Engineering (Preparatory)	½*	3*	
J 362	Arc Welding	½	3	
J 363	Gas Welding	½	3	

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[1] Credit should not be granted unless the successful completion of the course is validated by a measure of competence: a score on either the End-of-Course Test or the appropriate Subject Examination. Test results should be accepted only when reported directly to the educational institution by Headquarters, United States Armed Forces Institute, Madison 3, Wisconsin.

*No USAFI End-of-Course Test available. Credit in the amount recommended should be granted only upon the basis of appropriate local examination by the accrediting institution.

**No USAFI test available. Amount of credit should be determined by appropriate local examination by the accrediting institution.

		CREDIT RECOMMENDATION [1]		
		Units	*Semester Hours*	
NUMBER	COURSE NAME	*Secondary*	*Jr. Col. Terminal*	*Baccalaureate*
J 364	Patternmaking	½*	3*	
J 365	Foundry Practice I	½	3	
J 366	Foundry Practice II	½	3	
J 367	Introduction to Machine Industry	½	3	
J 368	Lathe and Milling Machine Operation	½*	3*	
J 369	Shapers, Planers and Grinding	½*	3*	
J 371	Metallurgy and Heat Treatment	½	3	
J 372	Metal Forging	½*	3*	
J 373	Toolmaking	½	3	
J 381	Elements of Mechanics	½	3	
J 382	Mechanical Principles	½*	3*	
J 383	Elementary Fluid Mechanics Prerequisite: Mathematics through calculus, statics, dynamics. Textbook: *Hydraulics*, Daugherty, R. L., 4th ed., 1937			3
J 384	Statics Prerequisite: Mathematics through calculus. Textbook: *Technical Mechanics*, Maurer and Roark, 5th ed., 1941			3
J 385	Dynamics Prerequisite: Mathematics through calculus, statics. Textbook: *Engineering Mechanics*, Brooke and Wilcox, 1929 ed.			3
J 386	Strength of Materials Prerequisite: Mathematics through calculus, physics, mechanical drawing. Textbook: *Resistance of Materials*, Seely, Fred B., 2nd ed., 1935; and *Steel Construction*, handbook published by American Institute of Steel Construction, 4th ed., 1943			3
J 388	Internal Combustion Engines: Introductory	½*	3*	
J 389	Principles of Diesel Engines	½	3	
J 390	Diesel Engines: Theory and Design	½*	3*	
J 391	Steam Engines, Turbines, and Pumps I	No credit unless presented with J 392		
J 392	Steam Engines, Turbines, and Pumps II For completion of this course and J 391.	½	3	
J 393	Refrigeration	1	6	
X 393	Refrigeration	1	6	
J 394	Municipal Engineering (Water Supply)	½*	3*	
J 395	Municipal Engineering (Sewage Disposal)	½*	3*	

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[1] Credit should not be granted unless the successful completion of the course is validated by a measure of competence: a score on either the End-of-Course Test or the appropriate Subject Examination. Test results should be accepted only when reported directly to the educational institution by Headquarters, United States Armed Forces Institute, Madison 3, Wisconsin.

*No USAFI End-of-Course Test available. Credit in the amount recommended should be granted only upon the basis of appropriate local examination by the accrediting institution.

		CREDIT RECOMMENDATION [1]		
		Units	*Semester Hours*	
NUMBER	COURSE NAME	*Secondary*	*Jr. Col. Terminal*	*Baccalaureate*
J 396	Fuel, Water, and Oil Systems of Diesel Engines	No credit for a single Diesel course (J 396, J 397, J 398, J 399). For any two of these courses:		
J 397	Diesel Engine Installation and Operation			
J 398	Diesel Engine Maintenance and Repair			
J 399	Diesel-Electric Power Plants	½	3	
J 412	Plastics	½*	3*	
X 412	Plastics	1	5	
J 416	Photography, Basic Processes	½	3	
X 416	Photography	½	3	
J 421	The Steam Locomotive	½	3	
J 422	Steam Locomotive Repair Work	½	3	
J 423	Locomotive Firing and Accessories	½	3	
J 425	Air Brakes, Locomotives	½*	3*	
J 427	Railroad Car Inspection, Mechanical	½*	3*	
J 428	Railroad Car Repair I	½*	3*	
J 429	Railroad Car Repair II	½*	3*	
J 430	Railroad Signaling	½*	3*	
J 432	Railroad Track Maintenance	½*	3*	
J 433	Railroad Rates	½	3	
J 434	Railway Transportation Textbook: *Economics of Transportation*, Locklin, D. Philip, 1938	1		3
J 435	Traffic Management	½	3	
J 496	Coast Guard Law Enforcement	½*	3*	
J 497	Marine Navigation I	2*	12*	
J 498	Marine Navigation II Textbooks: *American Practical Navigator*, Bowditch, Nathaniel, 1939; *Navigation and Nautical Astronomy*, Dutton, Benjamin, 1943; and supplementary materials	1*		6*
J 499	Marine Navigation III	No additional credit		

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[1] Credit should not be granted unless the successful completion of the course is validated by a measure of competence: a score on either the End-of-Course Test or the appropriate Subject Examination. Test results should be accepted only when reported directly to the educational institution by Headquarters, United States Armed Forces Institute, Madison 3, Wisconsin.

*No USAFI End-of-Course Test available. Credit in the amount recommended should be granted only upon the basis of appropriate local examination by the accrediting institution.

3. GENERAL COLLEGE CORRESPONDENCE COURSES

Number	Course Name	Credit Recommendation [1] Semester Hours
C 500	Introduction to Accounting I	3
C 501	Introduction to Accounting II	3
C 502	Intermediate Accounting I	3
X 502	Intermediate Accounting I	3
C 503	Intermediate Accounting II	3
X 503	Intermediate Accounting II	3
C 504	Cost Accounting	3
C 506	Auditing	3
C 507	C. P. A. Review Problems	3
C 516	Business Law I	3
C 517	Business Law II	3
C 518	Business Law III	3
C 526	Elements of Economics I	3
X 526	Elements of Economics I	3*
C 527	Elements of Economics II	3
X 527	Elements of Economics II	3*
C 528	Economic History of the United States	3
C 530	Money and Banking	3
C 533	Public Finance	3
C 535	Principles of Life Insurance	3
C 536	Economic Geography	3
X 536	Economic Geography	3
C 541	Advertising	3
C 542	Merchandising	3
C 543	Cooperative Marketing	3
C 544	Business Management, Policies and Methods	3
C 545	Personnel Management	3
X 545	Personnel Management	3
C 546	Office Management	3
C 547	Labor Problems	3
C 548	Introduction to Statistical Method	3
C 563	General Psychology	3
C 566	New-Type or Objective Examinations	3*
C 567	Principles of Adult Education	3
C 569	Statistical Methods in Education	3
C 581	Composition I	3
X 581	English Composition	3
C 582	Composition II	3
C 583	Survey of English Literature I	3
C 584	Survey of English Literature II	3
C 585	The Short Story I	3
C 587	Shakespeare I	3
C 588	Shakespeare II	3
C 589	History of English Literature	3
C 590	English Literature, Romanticism	3
C 591	The Contemporary Essay	3
C 592	English Literature, The Victorian Age	3
C 593	American Literature I	3

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General College Correspondence Courses

Number	Course Name	Credit Recommendation[1] Semester Hours
C 594	American Literature II	3
C 595	Newswriting	3
C 596	Feature Writing	3
C 623	Elements of Geography	3
C 624	The Geography of Europe	3
C 626	History of the United States, Colonial Period to the Civil War (1865)	3
C 627	History of the United States, Civil War to the Present	3
C 635	European History, 16th Century to the End of the Napoleonic Wars (Revised title: Modern European History)	3
C 636	Contemporary European History, World War I	3
C 637	Contemporary European History, World War I to World War II	3
C 638	Modern European History II	3
C 639	The British Empire	3
C 640	Latin America and the United States	3
X 640	Latin American Nations	3
C 641	American Federal Government	3
C 642	American State Government	3
C 643	World Politics, World War I to the Present	3
C 644	Municipal Government	3
C 645	The Nature of Society, Introduction to the Field of Sociology	3
X 645	Sociology	3
C 646	Social Problems	3
C 647	Rural Life	3
C 648	Criminology	3
C 649	The Technique of Municipal Administration	3*
C 650	Municipal Finance Administration	3*
C 651	Municipal Personnel Administration	3*
C 652	Municipal Police Administration	2*
C 653	Municipal Fire Administration	2*
C 654	Municipal Public Works Administration	2*
C 655	Municipal Recreation Administration	2*
C 656	Local Planning Administration	3*
C 661	Spoken French	**
C 662	Spoken Spanish	**
C 663	Spoken Italian	**
C 664	Spoken Portuguese	**
C 665	Spoken Turkish	**
C 666	Spoken Chinese	**
C 681	Intermediate French I	3
C 682	Intermediate French II	3
C 683	Intermediate French Composition	3
C 684	Intermediate German	3
C 685	Elementary German Composition I	3

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**No USAFI test available. Amount of credit should be determined by appropriate local examination by the accrediting institution.

Number	Course Name	Credit Recommendation [1] Semester Hours
C 687	Intermediate Spanish I	3
C 688	Intermediate Spanish II	3
C 689	Intermediate Composition, Spanish	3
C 690	Intermediate Norwegian	3
C 712	Plane Trigonometry	2
C 713	College Algebra and Trigonometry	3
X 713	College Algebra	3
C 714	Plane Analytic Geometry	3
C 715	Descriptive Geometry	2
C 716	Spherical Trigonometry	2
C 717	Differential Calculus	4
C 718	Integral Calculus	4
C 719	Solid Analytic Geometry	2
C 724	Differential Equations	3
C 725	Engineering Mathematics I	4
C 726	Engineering Mathematics II	4
C 748	General Geology	4
C 750	Weather and Climate	3
C 766	Principles of Business Correspondence	3

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THE ORIGINAL CORRESPONDENCE COURSES

		Credit Recommendation[1]		
		Units	*Semester Hours*	
Number	Course Name	*Secondary*	*Jr. Col. Terminal*	*Baccalaureate*
131	English Grammar	1		
132	Business Letter Writing	½		
311	American History	1		
341	Civics	½		
361	Economics	½		
411	Arithmetic	1		
431	Algebra	1		
441	Plane and Solid Geometry	1½		
451	Plane and Spherical Trigonometry	½		3
461	Analytic Geometry			3
471	Calculus			5
511	General Science (non-laboratory)	½		
521	Physics (non-laboratory)	½		
531	Inorganic Chemistry (non-laboratory)	½		
611	Typewriting	1		
621	Shorthand, Gregg	1		
622	Advanced Shorthand, Gregg	1		
631	Bookkeeping and Accounting	1		
632	Cost Accounting			4
633	Advanced Accounting			4
651	Railroad Rate Clerk	½	3	
652	Traffic Management	½	3	
701	Mechanical Engineering	½	3	
711	Steam Engineering	½	3	
721	Refrigeration I	½	3	
722	Refrigeration II	½	3	
723	Air Conditioning	½	3	
731	Automobiles	½	3	
732	Automobile Repairing	½	3	
733	Automobile Electric Technician	½	3	
734	Diesel Engines	½	3	
741	Aviation Engines	½	3	
742	Airplane Maintenance	½	3	
751	Marine Engineering (Preparatory)	½	3	
752	Marine Boilers	½	3	
753	Marine Engines	½	3	
754	Marine Equipment	½	3	
771	Plumbing	½	3	
772	Steam Fitting	½	3	
773	Heating	½	3	
791	Machine Shop Practice	1	6	
792	Gas Welding	½	3	
7X1	Mechanical Drawing	1	6	
7X2	Advanced Mechanical Drawing	1	6	
7X3	Plumbing Drawing	½	3	
7X4	Heating Drawing	½	3	

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		CREDIT RECOMMENDATION [1]		
		Units	*Semester Hours*	
NUMBER	COURSE NAME	*Secondary*	*Jr. Col. Terminal*	*Baccalaureate*
7X5	Machine Design	1	6	
811	Elementary Electricity	½	3	
812	Industrial Electricity	½	3	
813	Electrical Illumination	½	3	
814	Radio, Telephony, and Telegraphy	½	3	
821	Radio Operating I	½	3	
822	Radio Operating II	½	3	
823	Radio Operating III	½*	3*	
831	Basic Telegraphy and Telephony	½	3	
832	Commercial Telegraph Operating	½	3	
833	Practical Telephony	½	3	
892	Electric Welding	½	3	
911	Surveying and Mapping	½	3	
921	Engineering Mechanics	½	3	
931	Structural Engineering	½	3	
941	Water Works and Sewage Plant Operation	½	3	
951	Carpentry	½	3	

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EDUCATION MANUALS

1. SECONDARY SCHOOL AND TERMINAL JUNIOR COLLEGE SUBJECTS

Number	Name of Text and Author	Credit Recommendation[1]	
		Units	*Semester Hours*
		Secondary	*Jr. Col. Terminal*
EM 100	English Grammar, A. I. Spangler....	½	
EM 101	Mechanics of English, A. I. Spangler..	½	
EM 102	Building Good Sentences, A. I. Spangler..........................	½	
EM 200-203	American History (America: Its History and People, Faulkner and Kepner), 4 vols....................	1	
EM 204-206	History of Modern Europe (Modern History, Carl L. Becker), 3 vols...	1	
EM 209	History of China (A Short History of the Chinese People, L. C. Goodrich)	**	
EM 212-213	History of Latin America (History of Latin America for Schools, Inman and Castaneda)................	½	
EM 214-216	American Government (Government in Action, Keohane, Keohane, and McGoldrick)..................	½	
EM 218	American History (America: Its History and People, Faulkner and Kepner)......................	1	
EM 219	World History, Boak, Slosson, Preston, and Anderson, 2 vols........	1	
EM 221	American Economic Problems, Patterson, Little, and Burch............	½	
EM 222	Economic Geography, Colby and Foster........................	1	
EM 230	Economic Geography, Jones and Darkenwald....................	½	
EM 300-303	Review Arithmetic, Parts I and 2, Buswell, Brownell, and John: Practice Books 1 and 2, Schorling, Clark, Potter, and Deady..............	½	
EM 304	A First Course in Algebra I, V. S. Mallory......................	½	
EM 305	A First Course in Algebra II, V. S. Mallory...................... (EM 304 and EM 305 together constitute the equivalent of the usual first year of high school algebra)	½	
EM 306	Plane Geometry I (Modern-School Geometry, Clark and Smith)......	½	

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Number	Name of Text and Author	Credit Recommendation[1]	
		Units	*Semester Hours*
		Secondary	*Jr. Col. Terminal*
EM 307	Plane Geometry II (Modern-School Geometry, Clark and Smith) (EM 306 and EM 307 together constitute equivalent of usual year course in plane geometry)	½	
EM 308	Basic Mathematics I, W. Betz	½	
EM 309	Basic Mathematics II, W. Betz	½	
EM 310	Solid Geometry, Welchons and Krickenberger	½	
EM 311	Plane Trigonometry (Essentials of Trigonometry with Applications, Curtiss and Moulton)	½	
EM 400	Physics I: Mechanics (Modern Physics, C. E. Dull)	No credit	
EM 402	Physics II: Heat, Sound, and Light (Modern Physics, C. E. Dull) If presented with Em 400	½	
EM 404	Physics III: Electricity (Modern Physics, C. E. Dull) (The 3 courses in physics, EM 400, EM 402, and EM 404, together constitute the equivalent of one year of high school physics)	½	
EM 406	Basic Radio Code, Infantry School, Fort Benning, Georgia	**	
EM 415	Radio for Beginners (Elements of Radio, Marcus, Marcus, and Horton)	½	2
EM 416	Electricity for Beginners (Basic Electricity, Beauchamp and Mayfield)	½	3
EM 417	How to Use Your Eyes at Night, Science Service	No credit	
EM 426	Psychology and Life, F. L. Ruch	½	
EM 427	Elementary Meteorology, Finch, Trewartha, Caudle, and Shearer	½	
EM 428	Exploring Biology, E. T. Smith	1	
EM 430	Textbook of Healthful Living, H. S. Diehl	½	
EM 431	The Physical Sciences, Eby, Waugh, Welsh, and Buckingham	½	
EM 560	Latin Fundamentals, Hettrich and Maitland	1	6 sem. hrs. baccalaureate credit (*see also college list*)

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The following courses (EM 500 through EM 574, excepting EM 560, Latin Fundamentals) are functional, conversational language courses with emphasis on the spoken language. Mastery of the basic course gives the learner a knowledge of 1,000 to 1,500 words, a good pronunciation, and facility within the limitation of this vocabulary. Phonetic or simplified spelling is utilized. Each course includes units on meeting people, getting a room, shopping, seeing the sights, and other topics of daily conversation, with correct pronunciation and grammar integrated.

Number	Name of Text and Author	Credit Recommendation[1]	
		Units	*Semester Hours*
		Secondary	*Jr. Col. Terminal*
EM 500–501	Spoken French, Basic Course	**	
EM 503–504	Spoken Italian, Basic Course	**	
EM 506–507	Spoken Chinese, Basic Course	**	
EM 509–510	Spoken Spanish, Basic Course	**	
EM 512–513	Spoken Portuguese, Basic Course	**	
EM 515–516	Spoken Turkish, Basic Course	**	
EM 518–519	Spoken German, Basic Course	**	
EM 521–522	Spoken Hungarian, Basic Course	**	
EM 524–525	Spoken Russian, Basic Course	**	
EM 527–528	Melanesian Pidgin English	**	
EM 529–530	Spoken Dutch, Basic Course	**	
EM 532–533	Spoken Norwegian, Basic Course	**	
EM 535–536	Spoken Greek, Basic Course	**	
EM 538	Spoken Thai (Siamese), Basic Course	**	
EM 541–542	Spoken Burmese, Basic Course	**	
EM 544–545	Spoken Hindustani, Basic Course	**	
EM 550	Colloquial Dutch	**	
EM 551–552	Spoken Danish, Basic Course	**	
EM 560	Latin Fundamentals, Hettich and Maitland	See credit recommendation listed above following EM 431	
EM 561–562	Spoken Japanese, Basic Course	**	
EM 564–565	Spoken Korean, Basic Course	**	
EM 567–568	Spoken Malay, Basic Course	**	
EM 573–574	Spoken Serbo-Croatian, Basic Course	**	
EM 600	How to Sing and Read Music	No credit	
EM 616	How to Listen to Music (Music Appreciation, R. D. Welch)	½	
EM 630	Art Today, Faulkner, Ziegfeld, and Hill	½	
EM 700	Bookkeeping and Accounting I (20th Century Bookkeeping and Accounting, Carlson, Prickett, and Forkner) plus workbook	No credit unless presented with EM 702	

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		Units	*Semester Hours*
		Secondary	*Jr. Col. Terminal*
EM 702	Bookkeeping and Accounting II (20th Century Bookkeeping and Accounting, Carlson, Prickett, and Forkner) plus workbook and practice set If presented with EM 700.......	½	
EM 705	Bookkeeping and Accounting III (20th Century Bookkeeping and Accounting, Carlson, Prickett, and Forkner) plus workbook and practice set....	½	
EM 706	Applied Secretarial Practice, J. R. Gregg........................	½	
EM 708	Bookkeeping and Accounting IV (20th Century Bookkeeping and Accounting, Carlson, Prickett, and Forkner) plus workbook and practice set.....	½	
EM 711	Bookkeeping and Accounting V (20th Century Bookkeeping and Accounting, Carlson, Prickett, and Forkner)	½	
EM 714	The Small Business I: Organization (Business Principles and Management, Shilt and Wilson)..........	No credit unless presented with EM 715	
EM 715	The Small Business II: Operation (Business Principles and Management. Shilt and Wilson) If presented with EM 714.......	½	
EM 716	Introduction to Business Law I (Introduction to Business Law, Bogert, Goodman, and Moore)...........	½	
EM 717	Introduction to Business Law II (Introduction to Business Law, Bogert, Goodman, and Moore)........	½	
EM 718	Pitman Shorthand Speed Drills and Key, P Moser..................	1	
EM 720	Shorthand, Textbook and Workbook, J. R. Gregg.....................	1	
EM 722	Advanced Shorthand, J. R. Gregg...	1	
EM 725	Fundamentals of Typewriting (20th Century Typewriting, D. D. Lessenberry).......................	½	
EM 726	Business Typewriting (20th Century Typewriting, D. D. Lessenberry)...	½	
EM 728	Essentials of Business Arithmetic, Kanzer and Schaaf..............	½	

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Number	Name of Text and Author	Credit Recommendation [1] Units Secondary	Credit Recommendation [1] Semester Hours Jr. Col. Terminal
EM 730	Fundamentals of Advertising, Rowse and Fish	½	
EM 733	Business Principles and Management, Shilt and Wilson	½	
EM 735	Introduction to Business Law, Bogert, Goodman, and Moore	1	
EM 738	20th Century Bookkeeping and Accounting I, Carlson, Prickett, and Forkner	½	
EM 742	20th Century Bookkeeping and Accounting II, Carlson, Prickett, and Forkner	½	
EM 746	Business Filing, Bassett and Agnew	½	
EM 748	A Practical Course in Successful Selling, H. Simmons	½	
EM 749	Modern Business English, Davis, Lingham, and Stone	½	
EM 777	Office Machines Course, P. L. Agnew	½	
EM 786	Retailing: Principles and Practices, G. H. Richert	½	
EM 789	Fundamentals of Selling, Walters and Wingate	½	
EM 797	Business Economic Problems, Shields and Wilson	½	
EM 800	What Is Farming? U. S. Department of Agriculture. G. E. Larson. Editor	1	
EM 805	Dairy Farming (Dairy Cattle and Milk Production, Eckles, Anthony, and Palmer)	½	
EM 810	Managing a Farm, U. S. Department of Agriculture	1	
EM 815	Livestock Farming, W. Jackson	1	
EM 820	Poultry Farming (Successful Poultry Management, Morley A. Jull)	½	
EM 825	Soils (The Soils That Support Us, C. E. Kellogg)	½	
EM 826	Crops (Crop Management and Soil Conservation, Cox and Jackson)	½	
EM 852	Livestock Production, W. H. Peters	½	
EM 856	Successful Poultry Management, M. A. Jull	½	
EM 858	Crop Management and Soil Conservation, Cox and Jackson	1	
EM 862	Farm Shop Practice, M. S. Jones	½	
EM 864	Farm Records. J. A. Hopkins	½	
EM 866	Marketing of Farm Products, Norton and Scranton	½	

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NUMBER	NAME OF TEXT AND AUTHOR	CREDIT RECOMMENDATION[1]	
		Units	*Semester Hours*
		Secondary	*Jr. Col. Terminal*
EM 884	Growing Trees and Small Fruits, Knapp and Auchter.............	½	
EM 886	Forestry in Farm Management, Westveld and Peck..................	½	
EM 900–903	Military Correspondence (Adjutant General's School); Military Orders (Adjutant General's School); Basic Military Records I (Adjutant General's School); Basic Military Records II (Adjutant General's School) For completion of all four courses....................	½	3
EM 904	Army Typewriting (20th Century Typewriting, D. D. Lessenberry)...	½	
EM 905	Prison Work as a Career, Staff of Bureau of Prisons...............	½	3
EM 906	A Course in the Slide Rule and Logarithms, E. J. Hills...............	½	2
EM 907	Modern News Reporting, C. Warren.	½	
EM 909	Elementary Photography, G. G. Quarles........................	½	3
EM 910	Elements of Aeronautics, Pope and Otis..........................	1	5
EM 912	Blueprint Reading at Work, Rogers and Welton....................		1
EM 945	Your Post-War Career, prepared by the War Department...........	No credit	
EM 950–954	Auto Mechanics, R. F. Kuns: Five texts as follows: The Engine; Cooling, Lubrication, and Fuel Systems; Automotive Electricity; The Power Flow; Chassis, etc. Any of these courses, EM 950–954, may be presented separately......................	No secondary school credit is recommended for a single course. For any two courses, ½ unit; for 3 courses, 1 unit; for 4 courses, 1½ units; for all 5 courses, 2 units. For junior college terminal credit, 2 semester hours is recommended for each course.	
EM 957	Better Foremanship, G. Gardiner....	½	2

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NUMBER	NAME OF TEXT AND AUTHOR	CREDIT RECOMMENDATION [1]	
		Units	*Semester Hours*
		Secondary	*Jr. Col. Terminal*
EM 958	Foremanship and Supervision, F. Cushman		1
EM 959	Commercial Art, C. E. Wallace	½	3
EM 960	Mechanical Drawing, French and Svensen	1	6
EM 962	Principles and Practices of Radio Servicing, H. J. Hicks	2	10
EM 965	Machine Tool Operation I, H. D. Burghardt	1	6
EM 966	Machine Tool Operation II, H. D. Burghardt	1	6
EM 967	Industrial Electricity, Nadon and Gelmine	1	6
EM 968	Carpentry, Griffith and Cox	1	6
EM 970	Mathematics for Technical and Vocational Schools, Slade and Margolis	1	6
EM 971	Machine Shop Mathematics, A. Axelrod	1	5
EM 972	Mathematics Essential to Electricity and Radio, Cook and Orleans	1	6
EM 973	Carpentry Mathematics, Wilson and Rogers	½	3
EM 975	Electric Wiring, A. A. Schuhler	½	4
EM 976	How to Design and Install Plumbing	½	2
EM 977	Modern Electric and Gas Refrigeration, Althouse and Turnquist	1	6
EM 978	Air Conditioning, Heating, and Ventilating, Dalzell and Hubbard	1	5

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Small Business Series

The principal use of these books is in connection with EM 714 (The Small Business I) and EM 715 (The Small Business II) as supplementary reading in fields of particular interest to individual students. The books have been prepared under the direction of the Bureau of Foreign and Domestic Commerce of the United States Department of Commerce. Occasionally in units where there is sufficient student interest in particular fields, and where qualified instructors are available separate courses in some of the small businesses listed may be given. **It is recommended that credit be given for these separate courses only on the basis of institutional examinations.** The EM numbers and titles of this series are as follows:

NUMBER	COURSE NAME
EM 979	Establishing and Operating an Apparel Store
EM 980	Establishing and Operating an Automobile Repair Shop
EM 981	Establishing and Operating a Retail Bakery
EM 982	Establishing and Operating a Beauty Shop
EM 984	Establishing and Operating a Drug Store
EM 985	Establishing and Operating a Dry Cleaning Business
EM 986	Establishing and Operating an Electrical Appliance and Radio Shop
EM 987	Establishing and Operating a Grocery Store
EM 988	Establishing and Operating a Hardware Store
EM 989	Establishing and Operating a Service Station
EM 990	Establishing and Operating a Heating and Plumbing Contracting Business
EM 991	Establishing and Operating a Laundry
EM 992	Establishing and Operating a Metal Working Shop
EM 993	Establishing and Operating a Painting and Decorating Contracting Business
EM 994	Establishing and Operating a Real Estate and Insurance Brokerage Business
EM 995	Establishing and Operating a Restaurant
EM 996	Establishing and Operating a Small Sawmill Business
EM 997	Establishing and Operating a Shoe Repair Business
EM 998	Establishing and Operating a Variety and General Merchandise Store

2. COLLEGE SUBJECTS

Number	Name of Text and Author	Credit Recommendation[1] Semester Hours
EM 104	Writers Guide and Index to English, P. G. Perrin	3
EM 109	From Beowulf to Thomas Hardy, R. Shafer, 4 vols.	5
EM 114	American Life in Literature, edited by Jay B. Hubbell, 4 vols	6
EM 125	Principles and Types of Speech, A. H. Monroe	5
EM 130	Shakespeare, edited by T. M. Parrott	6
EM 131	Modern American and British Poetry, L. Untermeyer, 2 vols	6
EM 226	General Anthropology, F. Boas	3
EM 228	Elements of Geography, Finch and Trewartha, 2 vols	3
EM 230	Economic Geography, Jones and Darkenwald	3
EM 234	The Earth and the State, D. Whittlesey	3
EM 238	A Political and Cultural History of Modern Europe, Hayes and Carleton, 4 vols	6
EM 240	Medieval History, C. Stephenson	6
EM 242	A Survey of Ancient History, M. L. W. Laistner	5
EM 244	The People and Politics of Latin America, Mary W. Williams, 2 vols	3
EM 246	Civilization, Past and Present, Wallbank and Taylor, 2 vols	6
EM 248	A History of Russia, Sir Bernard Pares	2
EM 250	A History of the Far East in Modern Times, H. M. Vinacke	5
EM 252	Essentials of American Government, Ogg and Ray	3
EM 254	Governments of Continental Europe, J. T. Shotwell, *et al.*, 2 vols	5
EM 256	Contemporary International Politics, Sharp and Kirk, 4 vols	3
EM 260	Sociology, Ogburn and Nimkoff, 2 vols	3
EM 262	Social Pathology, J. L. Gillin	3*
EM 266	Principles of Criminology, E. H. Sutherland	4
EM 268	A Study of Rural Society, Kolb and Brunner	3
EM 270	American Political and Social History, H. U. Faulkner, 2 vols	5
EM 283	Introduction to Social Science, Abridged, Atterbury, *et al.*	4
EM 286	Elements of Healthful Life, H. S. Diehl	2
EM 295	Labor Problems in American Industry, C. R. Daugherty, 2 vols	3
EM 315	College Algebra, W. L. Hart	4
EM 318	Plane and Spherical Trigonometry with Tables, Kells, Kern, and Bland	4
EM 321	Elements of Analytic Geometry, C. E. Love	4
EM 324	Elements of the Differential and Integral Calculus, Granville, Smith, and Longley	6

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*No USAFI End-of-Course Test available. Credit in the amount recommended should be granted only upon the basis of appropriate local examination by the accrediting institution.

NUMBER	NAME OF TEXT AND AUTHOR	CREDIT RECOMMENDATION[1] *Semester Hours*
EM 327	An Introduction to Statistical Analysis, C. H. Richardson	3
EM 333	The Mathematics of Investment, W. L. Hart	4
EM 426	Psychology and Life, F. L. Ruch	3
EM 439	Astronomy, R. H. Baker	4
EM 442	Foundations of Biology, L. L. Woodruff, 2 vols	4
EM 445	A Textbook of General Botany, Holman and Robbins	2
EM 448	Animal Biology, M. F. Guyer, 2 vols	6
EM 451	Introductory College Chemistry, H. N. Holmes	4
EM 454	The Chemistry of Organic Compounds, J. B. Conant	6
EM 457	Elementary Quantitative Analysis, Willard and Furman	3
EM 460	Outlines of Physical Chemistry, Getman and Daniels	3
EM 463	Outlines of Historical Geology, Schuchert and Dunbar	2
EM 464	Outlines of Physical Geology, Longwell, Knopf, and Flint	4
EM 466	College Physics, Hausman and Slack, 4 vols	6
EM 469	Electricity and Magnetism, N. E. Gilbert	6
EM 472	The Machinery of the Body, Carlson and Johnson	3
EM 478	Principles of Abnormal Psychology, E. S. Conklin	3
EM 481	Principles of Applied Psychology, A. T. Poffenberger	3
EM 487	The Psychology of Adjustment, L. F. Shaffer	3
EM 490	Industrial Psychology, J. Tiffin	2
EM 491	Fundamentals of Physical Science, K. Krauskopf	6
EM 495	The Human Organism and the World of Life, Young, Stebbins, and Hylander	3
EM 560	Latin Fundamentals, Hettich and Maitland	6
EM 600	How to Sing and Read Music	No credit
EM 601	Harmony, W. Piston	6
EM 602	A History of Music, T. M. Finney	4
EM 603	Discovering Music, McKinney and Anderson	4
EM 610	Art Through the Ages, Helen Gardner, 2 vols	4
EM 612	America in Literature, T. McDowell	5
EM 615	An Introduction to Modern Philosophy, A. Castell	4
EM 616	How to Listen to Music (The Appreciation of Music, R. D. Welch) plus recordings	2
EM 618	Human Nature and Conduct, J. Dewey	2
EM 621	An Introduction to Logic and Scientific Method, Cohen and Nagel	3
EM 625	Preface to Philosophy	**
EM 630	Art Today, Faulkner and Hill	2
EM 703	Textbook of Office Management, Leffingwell and Robinson	3
EM 740	Real Estate Selling and Leasing, N. L. North	3
EM 754	Principles of Business Law, Dillavou and Howard, 2 vols	6

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**No USAFI test available. Amount of credit should be determined by appropriate local examination by the accrediting institution.

Number	Name of Text and Author	Credit Recommendation[1] *Semester Hours*
EM 756	Our Modern Banking and Monetary System, R. G. Thomas, 2 vols	3
EM 758	Life Insurance, J. B. MacLean	2
EM 759	Insurance, A. H. Mowbray	2
EM 761	Psychology Applied to Life and Work, H. W. Hepner, 2 vols	4
EM 763	Economics, Principles and Problems, Gemmill and Blodgett, 2 vols	6*
EM 764	Auditing Theory and Procedure, Sherwood and Culey	2
EM 767	Accounting Principles, Vol. I, McKinsey and Noble	3
EM 768	Accounting Principles, Vol. II, McKinsey and Noble	3
EM 772–773	Cost Accounting, Principles and Practice, J. J. W. Neuner	3
EM 779	Principles of Marketing, Clark and Clark	3
EM 781	Credits and Collections, Ettinger and Golieb	4
EM 783	Personnel Management and Industrial Relations, D. Yoder, 2 vols	2
EM 784	Wholesaling Principles and Practice, Beckman and Engle	2
EM 785	Merchandising Techniques, Hagadone and Beckley	3
EM 861	Farm Buildings, Carter and Foster	2
EM 870	Dairy Cattle, Yapp and Nevens	3
EM 871	Animal Sanitation and Disease Control, R. R. Dykstra	3
EM 873	Beef Cattle, R. R. Snapp	3
EM 874	Pork Production, W. W. Smith	3
EM 879	Diseases and Parasites of Poultry, Barger and Card	2
EM 880	Turkey Management, Marsden and Martin	2
EM 883	Cotton, H. B. Brown	4
EM 885	The Vegetable Growing Business, Watts and Watts	2
EM 886	Forestry in Farm Management, Westveld and Peck	2
EM 907	Modern News Reporting, C. Warren	2
EM 908	Surveying, C. Breed	3
EM 913	Introduction to American Public Education, C. A. DeYoung	2
EM 917	Educational Psychology, Gates, Jersild, McConnell, and Challman, 2 vols	3
EM 921	Foundations of Modern Education, E. H. Wilds	2
EM 929	Fundamentals of Public School Administration, W. G. Reeder	3
EM 932	Progressive Methods of Teaching in Secondary Schools, N. L. Bossing, 2 vols	2
EM 935	Modern Secondary Education, A. A. Douglas	2
EM 939	Measurement and Evaluation in the Secondary School, Greene, Jorgensen, and Gerberich	2
EM 942	An Introduction to American Forestry, S. W. Allen	2
EM 961	Engineering Drawing, T. E. French	4

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*No USAFI End-of-Course Test available. Credit in the amount recommended should be granted only upon the basis of appropriate local examination by the accrediting institution.

SUBJECT EXAMINATIONS

1. SECONDARY SCHOOL LEVEL

Test	Carnegie Units	Suggested Minimum Score			
		Form A		Form B	
Algebra, Elementary	1	16		16	
Algebra, Second Year	½	16		17	
Arithmetic, Advanced (8th grade)	—	23		20	
Arithmetic, Business	1	25		28	
[a]Auto Mechanics	1	95		Not available	
Biology	1	70		73	
Bookkeeping and Accounting, 1st year	1				
Minimum scores on each section:					
Section A		21		20	
Section B		8		8	
Section C		28		27	
Section D		15		15	
Or Total on complete test		83		80	
Bookkeeping and Accounting, 2nd year	1				
Minimum scores on each section:					
Section A		17		14 T	
Section B		7		8 T	
Section C		50		53 T	
Section D		22		22 T	
Or Total on complete test		103		107 T	
Chemistry, General	1	37		32	
Civics	½	46		42	
Drawing, Mechanical	1	70		57	
English		Book I	Book II	Book I	Book II
Recommended credit for 3 levels of achievement:					
Grade 10	1	50	32	46	34
Grade 11	2	55	36	52	37
Grade 12	3	60	40	57	40
English, Business	½	85		87	
French, Lower Level	1 or 2	1 unit	2 units	1 unit	2 units
Vocabulary		21	37	23	37
Reading Comprehension		10	17	10	16
Grammar		14	22	14	22
French, Upper Level	3 or 4	3 units	4 units	3 units	4 units
Vocabulary		28 T	36 T	34 T	41 T
Reading Comprehension		18 T	22 T	17 T	21 T
Grammar		21 T	27 T	19 T	25 T
Geometry, Plane	1	14		15	
Geometry, Solid	½	14		Not available	

[a] 5 semester hours Junior College Terminal.

Test	Carnegie Units	Suggested Minimum Score			
		Form A		Form B	
German, Lower Level	1 or 2	1 unit	2 units	1 unit	2 units
Vocabulary		19	29	16	24
Reading Comprehension		9	12	9	12
Grammar		21	30	21	30
History, American	1	50		51	
History, Modern European	1	44		45	
History, World	1	65		58	
Italian, Lower Level	1 or 2	1 unit	2 units	1 unit	2 units
Vocabulary		25	34	25 T	34 T
Reading Comprehension		14	20	12 T	20 T
Grammar		18	25	18 T	25 T
Meteorology	½	37 T		37 T	
Physics	1	29		23	
Problems of Democracy	1	42		43	
Radio	1	60		Not available	
Science, General	1	54		55	
Science, Senior	1	37		38	
Shorthand, Gregg, 1st year	1				
Section A		40		38	
Section B		60		66	
Spanish, Lower Level	1 or 2	1 unit	2 units	1 unit	2 units
Vocabulary		22	33	25	36
Reading Comprehension		13	18	15	19
Grammar		17	20	17	20
Typewriting, 1st year	1	279		283	
Typewriting, 2nd year	1	300		307	

SUBJECT EXAMINATIONS

2. COLLEGE LEVEL

Test	Sem. Hours	Suggested Minimum Score	
		Form A	Form B
Algebra, College	3–5	20	20
Astronomy	3	34 T	34 T
Aviation Engines	3	55 T	Not available
Biology	3	60	61
Botany	3	66	61
Calculus I, Differential	4–5	25	32
Calculus II, Integral	4–5	22	22 T
Chemistry, General	6–8	42	41
Chemistry, Organic	6–8	31	31 T
Chemistry, Physical	6–8	29 T	29 T
Chemistry, Qualitative Analysis	3–4	22	22 T
Chemistry, Quantitative Analysis	6–8	22	22 T
Commercial Correspondence	3	110	107
Drawing, Engineering	4–6	54	50
Economics	5–6	65 T	Not available
Electricity and Magnetism	3–4	23 T	23 T
Electron Tubes and Circuits	6	46 T	46 T
Electronics, Engineering	4	46 T	46 T
Electronics, Engineering, Advanced	4	40 T	40 T
Engineering, Diesel	3–4	58 T	58 T
Engineering, Mechanics	5–6	36 T	36 T
English	6	Book I Book II	Book I Book II
		76 32	78 34
French, Lower Level	6–8		
Vocabulary		37	37
Reading Comprehension		19	18
Grammar		23	23
French, Upper Level	6–8		
Vocabulary		28	34
Reading Comprehension		15	14
Grammar		23	21
Geometry, Analytic	3–5	25	24
German, Lower Level	6–8		
Vocabulary		29	24
Reading Comprehension		11	11
Grammar		31	31
Government, American	6	56	Not available
History, American	3	65	65
History, Modern European	3	56	57
Italian, Lower Level	6–8		
Vocabulary		26 T	26 T
Reading Comprehension		19 T	19 T
Grammar		24 T	24 T
Machine Design	3–4	43 T	43 T
Mechanics, Fluid	3	20 T	20 T
Physics, General	6–8	40 T	40 T

Test	Sem. Hours	Suggested Minimum Score			
		Form A		Form B	
Psychology, General, Elementary	3–6	3 Sem. Hrs.	6 Sem. Hrs.	3 Sem. Hrs.	6 Sem. Hrs.
		40	56	39	54
Radio Engineering I	4	45 T		45 T	
Radio Engineering II	4	45 T		45 T	
Spanish, Lower Level	6–8				
Vocabulary		33		36	
Reading Comprehension		18		19	
Grammar		23		23	
Strength of Materials	4	67 T		67 T	
Surveying	6–7	34 T		34 T	
Trigonometry, Plane	3	18		21	
Zoology	6	88		Not available	

1. Locations:

Shrivenham American University, Shrivenham, England
Biarritz American University, Biarritz, France
The University Study Center, Florence, Italy
Army University Center, Oahu, Hawaii

NOTE: The above-named University Centers are no longer in existence. However, since certificates of completion may still be presented for academic credit, the description of the program as it appeared in the original *Guide* materials is reprinted. There are a number of other *study centers* in various theatres, the names of which may cause them to be confused with these University Study Centers. An illustration is Rainbow University at Zell am See, Austria. Here courses have been established on Education Manuals. Its work, and the work of similar centers, should be evaluated as indicated in the *Guide* under USAFI 1A, Education Manuals, and not as provided below for the University Study Centers.

2. Length of Term:

The normal term is eight weeks and the normal student schedule is three courses, each meeting five times per week. At Florence terms have been shortened to four weeks, though most full courses are on an eight weeks' basis. Provisions have been made for certifying the completion of partial courses where as much as 20 hours of work (½ of the total course) has been finished. Speeding up of redeployment of high point men, due largely to the sudden collapse of Japan, was the primary reason for the shorter term. At Oahu the term is four weeks, but courses meet for ten hours per week.

3. Enrollment:

Student quotas for the three European centers are as follows: Shrivenham, 4,000; Biarritz, 4,000; Florence, 3,000. While actual registration figures are incomplete, it would appear that quotas were not completely met in the first term. All centers reported anticipated full quotas for the second term. Especially during the first term scheduled for eight weeks, withdrawals because of redeployment were numerous. Beginning with the second term, it became the policy to admit high point men only provided they would sign an agreement to remain and complete their courses even though their opportunity to return to the U. S. might come before the end of the term. Most students remain enrolled for no more than one term, though provisions are made for the continuation of a few students for a second term.

4. Entrance Requirements:

In general, high school graduation has been the accepted minimum standard for admission. From Shrivenham it is reported that slightly more than two-thirds of the students admitted to the first class had previously attended college and practically all were high school graduates.

A sampling of 34 percent of the first student body at Florence indicated the following percentages of previous preparation:

Previous Preparation	*Percentage*
Grade school only	1
Some high school	6
High school graduate only	42
Some college work	40
College graduate	9
Some postgraduate work	2

If this is representative of the entire group, it means that 93 percent of the students were as advanced educationally as students in civilian higher institutions.

5. Program of Work:

In general the program of work is at the undergraduate college level including courses of all years, freshmen, sophomore, junior, and senior. Course offerings and general organization of this work at all centers are fairly represented by the following list of courses announced in August 1945 for Biarritz:

Agriculture Section

Agronomy
Forestry
Horticulture
Animal and Dairy Husbandry
Farm Management

Commerce Section

Accounting
Administration and Marketing
Economics and Finance
Secretarial Studies

Education Section

Administration
Curriculum and Instruction
Educational Psychology
Educational Seminar
History of Philosophy of Education

Engineering Section

Aeronautical
Civil
Electrical
Mechanical
Sanitary

Fine Arts Section

Graphic and Plastic Arts
Music

Journalism Section

History
Editorial
Advertising
Newspaper Management

Liberal Arts Section

English
Geography
Foreign Language
History
Philosophy
Political Science
Psychology
Sociology
Speech and Dramatic Arts

Science Section

Biological Sciences
Chemistry
Geology
Mathematics
Physics

6. Preparation of the Faculty:

The faculties of the centers have been chosen from Army personnel and from civilian institutions. Over 350 members of the staffs have been recruited from civilian institutions. Those selected as civilian administrators and supervisors of the European program have included: John Dale Russell, University of Chicago; Elmer T. Peterson, State University of Iowa; Julian Boatman, U.S. Department of Agriculture; James R. Hawkinson, Northwestern University; Luther T. Mott, University of Missouri. The complete faculty lists for the three European centers have been available to the staff and consultants for the *Guide*. The number, the preparation, and previous teaching experience of the staffs including civilians and men of the services may be summarized as follows:

1. NUMBER AND PREPARATION OF STAFF

Center	*Total Number*	*Percentage Holding Degree of* *Ph. D.*	*Masters*	*Bachelors*	*Others or Unknown*
Biarritz..........	269	42	34	18	6
Florence........	205	21	32	39	8
Shrivenham.....	214	48	35	11	6

2. PREVIOUS TEACHING EXPERIENCE OF STAFF

Center	*Percentage Who Have Taught in* *College or University*	*Junior College*	*Secondary School*	*Others or Unknown*
Biarritz.................	76	3	7	14
Florence................	50	2	19	29
Shrivenham............	82	3	7	8

7. Equipment:

Instructional materials adapted or developed by the U. S. Armed Forces Institute, including standard textbooks (many of these are the Education Manuals discussed elsewhere in this section of the *Guide*), instructors' course outlines, library and reference materials, educational films and film strips, and graphic charts comprise the principal instructional materials of the present program in Europe. Educational tours are arranged for the purpose of implementing the instruction in various courses.

Every effort has been made to supply the centers with essential library and laboratory equipment. At Florence on July 21, the library contained 5,850 volumes of 837 different titles, with 1,200 additional volumes of the same titles held in reserve to be put into use when needed. Five hundred seventy of these titles were non-fiction. By September 7, the number of volumes had increased to 9,000. The library of the University of Florence and other libraries in the city are open to students of the University Study Center at Florence. The Oxford University library is available to students at Shrivenham.

An article appearing in the *Shrivenham Post*, student newspaper, under date of September 19, 1945, makes the following statement about the job performed by Academic Supply:

"Academic Supply has unloaded over 55,000 books since SAU opened its doors six weeks ago. But books aren't all. Thousands of pencils and rulers have been handled along with notebooks and paper. Laboratory supplies include hundreds of Bunsen burners, beakers, scales, dissecting equipment and countless other items. Art students were furnished oil and water paints, brushes of all kinds, and drawing boards and art paper. Such technical items as basal metabolism apparatus, hemocytometers and sphygmometers were destined for SAU's many dispensaries."

8. Recommendations:

It is recommended that 3[1] semester hours of credit be granted toward a baccalaureate degree for each course certified as satisfactorily completed. (A full course is a subject pursued for eight weeks with 5 class meetings per week, or the equivalent in laboratory or drawing room, or, at Oahu, a subject pursued for four weeks with ten hours of instruction per week.) If the certification indicates that less than a full term of work has been completed, it is recommended that credit be based upon examinations, such as those prepared by USAFI. It is further suggested that in many instances it may be practicable for the institution to use its own examinations or to devise examinations covering the parts of courses which the applicant indicates he has had.

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[1] The original recommendation was 2½ semester hours for each course; since most institutions whose faculty members taught in the program granted 3 semester hours for each course, the program was re-evaluated in 1946 and the credit recommendation was changed to 3 semester hours.

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M USE
OCT 20 1958
CT 27 1958
Rm use
G 6 1959
Rm use
C 17 1959
s. use
6 1961

Service Paper
McGowan, L. R.
1949

McGowan, Lawrence R.
Instructioal materials and methods available to supplement a small high school........

DATE

Robert

AUG 1 '49

Ed.

Service Paper
1949
McGowan, L. R.